Volume THREE

FINAL ENVIRONMENTAL IMPACT STATEMENT

Red Line Extension Harvard Square to Arlington Heights

Boston, Massachusetts

MA-23-9008

August 1977

U.S. Department of Transportation
Urban Mass Transportation Administration

FINAL ENVIRONMENTAL IMPACT STATEMENT
AND 4(f) STATEMENT

U.S. Department of Transportation
Urban Mass Transportation Administration

RED LINE EXTENSION - HARVARD SQUARE
ARLINGTON HEIGHTS, BOSTON, MASSACHUSETTS

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

UMTA PROJECT: MA-23-9008

This transportation improvement is proposed for funding under the Interstate substitution provision of the Federal-Aid Highway Program - Title 23 United States Code Section 103 (e)(4).

The statement is submitted pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969(PL91-190); Section 3(d) and 14 of the Urban Mass Transportation Act of 1964 as amended; Section 4(f) of the Department of Transportation Act of 1966; and Section 106 of the National Historic Preservation Act of 1966.

AUG 16 1977

DATE

By: John K. Taylor

John K. Taylor
Acting Associate Administrator
for Transit Assistance

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(Harvard Square to Arlington Heights)

Appendix A

LIST OF AGENCIES, BUSINESS AND CITIZEN GROUPS AND BUSINESSES CONTACTED
(Harvard Square to Arlington Heights)

REGIONAL AND FEDERAL AGENCIES

Massachusetts Bay Transportation Authority
Metropolitan Area Planning Council
Central Transportation Planning Staff
Executive Office Transportation & Construction
Massachusetts Department of Public Works
Executive Office of Environmental Affairs
Metropolitan District Commission
Urban Mass Transit Administration
Federal Highway Administration
U. S. Department of the Interior, Fish & Wildlife Service
Environmental Protection Agency

MUNICIPAL AGENCIES

Arlington

Department of Planning & Community Development
Redevelopment Board
Board of Selectmen
Selectmen's Transportation Advisory Committee
Town Engineer
Public Works Department
Department of Parks and Recreation
Council for the Aging
Director of Community Safety: Police & Fire Departments
Conservation Commission
Historical Commission
Arlington Public Schools
Arlington Housing Authority
Librarian, Robbins Library

Cambridge

City Council
Community Development Department
Historical Commission
Public Works Department

Cambridge (Cont'd)

Engineering Department
Department of Parking & Traffic
Conservation Commission
Planning Board
Librarian, Cambridge Public Library

Belmont

Conservation Commission
Engineering Department

Somerville

Planning Board
Engineering Department
Department of Public Works
Highway Department
Water Department
Sewer Department
Conservation Commission
Historic Project Coordinator
Historical Commission
Public Information Coordinator

PRIVATE BUSINESS & CITIZEN GROUPS

Arlington

Conservation Association
East Arlington Neighborhood Association
Chamber of Commerce
League of Women Voters
Historical Society
Citizens Involvement Committee
St. Agnes Parish Task Force

Cambridge

Chamber of Commerce
Porter Square Businessmen's Association
North Cambridge Planning Team
Walden Street Association
Neighborhood 9 Association
Agassiz Neighborhood Association
Jefferson Park Council of Tenants
Rindge Towers Tenants
Neighborhood 10 Association
Fresh Pond Parkway Neighbors' Association

Belmont

Winn Brook Association

Somerville

Ward Six Civic Association
Chamber ot Commerce
Davis Square Businessmen's Association

Regional

Red Line Working Committee
Citizens for Rail Transportation
Sierra Club
Mystic River Watershed Association
Hanscom Field Task Force
Massachusetts Audubon Society
Massachusetts Historic Society
League of Women Voters of Massachusetts
Norumbega Association

BUSINESSES

Cambridge

W. R. Grace & Company
Hayes Oil
Rindge Towers Management
Sears, Roebuck & Company
West End Iron Works
A. D. Little, Inc.
B & M Realty
J. D. Lyons, Inc.
Cabbages & Kings Gift Shop
Igo's Restaurant
Carmine's Modern Barber Shop
The Flag Center
Tag's Hardware
H & R Block
Mini Carpet Shop

Arlington

Arlington Five Cents Savings Bank
Malcolm Stevens Company
Brigham's
Mugar Developers

Arlington (Cont'd)

Larson and Sons
New England Farms
Arlington Coal & Lumber
Mirak Chevrolet
Atlantic Roofing and Skylight Company

Somerville

Comfort Pillow & Feather Company
Urban Equity Development Company
Middlesex Federal Savings and Loan Association
Pine Tree Diner
La Pinata Restaurnat
Fine Arts Cleaners
Barbara Tiffany School of Dance
Repro Tech Corporation
Johnson-Foster Company
Davis Square Wallpaper Company
D & J Outlet
Gas Light Pub
Kolokithas Upholstery Company

Regional

Boston & Maine Railroad
Boston Gas Company
New England Telephone Company
Algonquin Gas Transmission Company
Commonwealth Gas Company

LIST OF AGENCIES, BUSINESS AND CITIZEN GROUPS AND BUSINESSES CONTACTED
(Harvard Square Area)

Cambridge Citizen Organizations

Harvard Square Development Task Force
Cambridge Transportation Forum
Cambridge Chamber of Commerce
Transportation Committee
Cambridge Civic Association
Harvard Square Businessmen's Association
Neighborhood Ten Association
Neighborhood Nine Association
Planning for People
Riverside Cambridgeport Community Corporation
Hilliard Street Residents
Mid-Cambridge Neighborhood Association

City Agencies/Officials

Department of Community Development
(Working Sessions)
City Traffic Department
Cambridge Redevelopment Authority
Ted Monacelli, Urban Design Consultant
Cambridge Historical Commission
City Council Transportation Committee
City Council
City Manager

State/Regional Agencies

MBTA (Operations Staff)
Central Transportation Planning Staff
Mass. Historical Commission
Red Line Working Committee

Others

Harvard University, Office of Planning
Office of Community Affairs
MIT Laboratory of Architecture and Planning

Others (Cont'd)

Kennedy Library, Chief Engineer
C. E. Maguire, Inc.
Harvard Cooperative Society
Urban Mass Transportation Administration
Environmental Officer

APPENDIX B

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APPENDIX C

PROBABLE MAMMALS IN THE RED LINE EXTENSION CORRIDOR

Appendix C

PROBABLE MAMMALS IN THE RED LINE EXTENSION CORRIDOR

Opossum	Didelphis marsupialis
Masked Shrew	Sorex cinereus
Shorttail Shrew	Blarina brevicauda
Starnose Mole	Condylura cristata
Eastern Mole	Scalopus aquaticus
Keen Myotis	Myotis keeni
Eastern Pipistrel	Pipistrellus subflavus
Big Brown Bat	Eptesicus fuscus
Raccoon	Procyon lotor
Longtail Weasel	Mustela frenata
Mink	Mustela vison
Striped Skunk	Mephitis mephitis
Woodchuck	Marmota monax
Eastern Chipmunk	Tamias striatus
Eastern Gray Squirrel	Sciurus carolinensis
White-footed Mouse	Peromyscus leucopus
Meadow Vole	Microtus pennsylvanicus
Muskrat	Ondatra zibethica
Norway Rat	Rattus norvegicus
House Mouse	Mus musculus
Meadow Jumping Mouse	Zapus hudsonius
Eastern Cottontail	Sylvilagus floridanus
Whitetail Deer	Odocoileus virginianus

Sources: Burt, W. H. and R. P. Grossenheider. 1964. A Field Guide to the Mammals. 2nd Ed. and P. S. Mugford, Massachusetts Department of Natural Resources, Division of Fish and Game, personal communication.

Appendix C Probable Migratory and Resident Birds in the Red Line Extension Corridor

Podicipediformes
- Pied-billed Grebe

Pelecaniformes
- Double-crested Cormorant

Ciconiiformes
- Great Blue Heron*
- Green Heron*

Anseriformes
- Canadian Goose*
- Mallard*
- Black Duck*
- Pintail
- American Wigeon
- Wood Duck
- Lesser Scaup
- Common Goldeneye
- Bufflehead
- Ruddy Duck
- Common Merganser

Falconiformes
- Red-tail Hawk*
- Red-shouldered Hawk
- American Kestrel

Galliformes
- Ruffed Grouse
- Ring-necked Pheasant*

Gruiformes
- American Coot*

Charadriiformes
- Killdeer
- American Woodcock
- Spotted Sandpiper
- Solitary Sandpiper
- Great Black-backed Gull*
- Herring Gull*

Columbiformes
- Rock Dove*
- Mourning Dove

Caprimulgiformes
- Whip-poor-will
- Common Nighthawk

Apodiformes
- Chimney Swift

Piciformes
- Common Flicker*
- Hairy Woodpecker
- Downy Woodpecker*

Passeriformes
- Eastern Kingbird
- Great Crested Flycatcher
- Eastern Wood Pewee
- Tree Swallow*
- Barn Swallow*
- Blue Jay*
- Common Crow*
- Black-capped Chickadee*
- Tufted Titmouse
- White-breasted Nuthatch*
- Brown Creeper
- House Wren
- Mockingbird
- Gray Catbird
- Brown Thrasher
- American Robin
- Wood Thrush
- Veery
- Golden-crowned Kinglet
- Ruby-crowned Kinglet
- Starling*
- Red-eyed Vireo
- Black and White Warbler
- Nashville Warbler
- Northern Parula Warbler
- Yellow Warbler
- Magnolia Warbler
- Black-throated Blue Warbler
- Yellow-rumped Warbler
- Chestnut-sided Warbler
- Blackpool Warbler
- Ovenbird
- Common Yellowthroat
- Wilson's Warbler
- Canada Warbler
- American Redstart
- House Sparrow*
- Eastern Meadowlark
- Red-winged Blackbird*
- Northern Oriole
- Common Grackle*
- Brown-headed Cowbird
- Scarlet Tanager
- Cardinal*
- Rose-breasted Grosbeak
- American Goldfinch
- Rufour-sided Towhee
- Dark-eyed Junco*
- Tree Sparrow*
- Chipping Sparrow
- Field Sparrow
- White-throated Sparrow
- Fox Sparrow
- Song Sparrow*

Compiled from: Wiggin, H. T. 1974. "Birds of Brookline, Massachusetts 1965-1974" and Massachusetts Audubon Society Daily Field Card.

*Reported sightings in Alewife wetlands environs, various sources.

Additions

Black-crowned Night Heron
Osprey
Sparrow Hawk
Sora Rail
Ring-billed Gull

Appendix C

Water Quality Summary for Mystic River Drainage. Adopted from Metropolitan District Commission water quality data, September 1972 through September 1974. Averaged parameter value is followed by recorded extremes in parentheses. Units in milligrams/liter except as noted

Station Location

Parameter	Upper Mystic Lakes Dam Overflow		Mill Brook at Mystic Valley Parkway		Mystic River at Route 60		Alewife Brook at Dilboy Field		Mystic River at Winthrop Street		Mystic River Amelia Earhard Dam		Applicable Standard
Temperature (° F)	60	(36 - 80)	57	(35 - 76)	58	(35 - 78)	58	(35 - 78)	58	(34 - 80)	57	(34 - 81)	Less than 83°F[1]
pH (standard units)	7.1	(6.8-7.4)	7.0	(6.5-7.3)	7.1	(6.7-7.3)	7.0	(6.7-7.4)	7.0	(6.8-7.4)	7.3	(7.0-7.8)	6.5-8.0[1]
Dissolved Oxygen	9.3	(7.8-12.2)	9.4	(6.2-12.6)	9.5	(7.2-13.0)	6.9	(3.6-10.0)	8.6	(5.0-12.6)	9.8	(4.2-13.0)	Greater than 5 mg/l [1]
BOD	3.8	(1.8-6.4)	7.0	(2.8-36.2)	4.2	(2.6-6.2)	9.6	(3.4-32.6)	8.3	(2.0-28.6)	6.7	(3.6-18.6)	*
Total Coliform x100/100ml.	2.6	(0-18.7)	23.4	(3.0-94.0)	9.5	(0.4-80.0)	49.2	(2.4-184.0)	32.9	(3.0-13.0)	4.5	(0.1-16.0)	Less than 1000/ 100 ml. [1]
Chlorides	107	(80 - 130)	90	(60 - 125)	109	(10 - 170)	82	(10 - 130)	117	(80 - 150)	170	(105 - 305)	Less than 250 mg/l [2]
Ammonia Nitrogen	2.9	(0.6-5.1)	1.3	(0.4-5.0)	2.5	(0.5-10.5)	1.1	(0.5-2.1)	1.7	(0.4-4.9)	2.2	(0.1-13.3)	Less than 0.5 mg/l [2]
Total Nitrogen	4.5	(0.9-10.0)	2.6	(1.1-7.2)	5.5	(1.3-30.4)	2.2	(1.4-3.4)	2.7	(1.1-7.2)	2.2	(0.6-4.3)	*
Total Phospate	4.1	(0.4-9.2)	6.0	(3.2-11.6)	3.1	(0.1-6.2)	4.5	(0.1-10.2)	3.7	(0.1-6.5)	3.8	(0.1-6.8)	*

1 State of Massachusetts Water Quality Standards, Class B waters (most stringent classification in study corridor).

2 Recommended limit for public water supplies. From Water Quality Criteria 1972, National Academy of Sciences and National Academy of Engineering report to the Environmental Protection Agency.

* No standard available

APPENDIX D

NOISE AND VIBRATION CRITERIA

APPENDIX D

NOISE AND VIBRATION CRITERIA

Fundamental Concepts

The purpose of an environmental noise impact analysis in connection with the proposed rapid transit system is to determine and report the change in noise impact on the community which can be expected as a result of the completion and operation of the transit system. The concept of noise impact depends upon the relationships which have already been established between people's reactions to noise and the appropriate physical measures of noise.

This section provides the background information on the characteristics of environmental noise, the reactions of people to environmental noise, and the evolution of noise impact criteria applied to this particular study.

Three dimensions of environmental noise are important in determining man's subjective response. These are:

1. The intensity or level of the sound;

2. The frequency spectrum of the sound; and

3. The time-varying character of the sound.

Sound levels are measured on a logarithmic scale and expressed in decibels (dB, with 0dB corresponding roughly to the threshold of sensitivity of hearing).

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. The "frequency" of a sound refers to the number of complete pressure fluctuations per second. The unit of measurement is the cycle per second or hertz (Hz). Most of the sounds which we hear do not consist of a single frequency, but are composed of a broad band of frequencies, differing in relative level. The quantitative expression of the frequency and level content of a sound is its sound spectrum. Many rating methods have been devised to permit comparison of sounds having quite different spectra. Fortunately, the simplest method correlates with human response, for practical purposes, as well as the more complex methods. This method consists of evaluating all of the contents of a sound in accordance with a weighting that progressively and severely de-

emphasizes the importance of frequency components below 1000 Hz, with mild de-emphasis above 5000 Hz. This type of frequency weighting reflects the fact that human hearing is less sensitive at low and extremely high frequencies than in the frequency mid-range. The weighting curve most often used is called "A" weighting, and the level so measured is called the "A-weighted sound level", or simply "A-level".

The A-level in decibels is expressed "dBA"; the appended letter "A" is a reminder of the particular kind of weighting used for the measurement. In practice, the A-level of a sound source is conveniently measured by using a sound level meter that includes an electric filter corresponding to the A-weighting curve. All U.S. and international standard sound level meters include such a filter.

Although the A-level may adequately describe environmental noise at any given instance in time, the fact is that the community noise levels vary continuously. Most environmental noise includes a conglomeration of distance noise sources which creates a relatively steady background noise in which no particular source is identifiable. These distant sources may include noises created by traffic, wind in trees, industrial or farming activities, etc. These sources are relatively constant from moment to moment, but vary slowly from hour to hour as natural forces change or as human activity follows its daily cycle. Superimposed on this slowly-varying background is a succession of identifiable noisy events of brief duration. These may include nearby activities or the passage of single vehicles, aircraft flyovers, etc., which cause the environmental noise level to vary from instant to instant.

One accepted practice used in describing sounds which vary with time is to analyze them statistically in order to determine sound levels which are exceeded for some percent of a specific time. The average or median sound level is the A-level exceeded 50 per cent of the time, and is designated as L_{50}. The noise exposure criteria of the U.S. Department of Housing and Urban Development (HUD) are based upon A-levels exceeded 33-1/3 per cent of the time (designated L_{33}). In order to compare highway noise impact data, some data in this report are expressed in terms of the A-level exceeded ten per cent of the time (designated L_{10}), which is the statistical measure preferred by the FHWA. For a description of the background sound level, or the sound remaining during lulls in the single noise events, the level exceeded for 90 percent of the time (L_{90}) is often used. A reasonably reliable characterization of noise exposure at a given location results from stating the L_{10}, L_{50} and L_{90} for a specified portion of the day.

In the interest of avoiding complicated descriptions and simplifying

the definition of noise exposure, a single-number average sound level was used to define the fluctuation of noise at a given location. It was first used in Europe and has recently become popular in the United States largely through the efforts of the Environmental Protection Agency (EPA). The average sound level is the steady noise level that would convey the same noise energy, in the same time period, as the actual time-varying noise. This "equivalent steady noise", designated L_{eq}, is called at various times the "mean energy sound level", the "average sound level", or the "equivalent sound level". The time periods over which the equivalent sound level is usually expressed are by hour, by eight hour working day, by day (defined as the hours from 0700 to 2200), by night (defined as the hours from 2200 to 0700), and by 24-hour day.

A modification of the 24-hour equivalent sound level is the "Day-Night Sound Level" which incorporates a 10dB penalty for all noise occurring during the nightime period between the hours of 10PM to 7AM. As proposed by EPA, the Day-Night Sound Level (L_{dn}), is the descriptor to be used for general noise that affects a community over the full 24 hour day.

Finally, single noise events like transit train passages which are easily identifiable over the background are characterized by their maximum A-weighted sound level, L_{max}. The various measures of environmental noise are summarized in Table D-1.

TABLE D-1
COMMON MEASURES OF ENVIRONMENTAL NOISE

Noise Measure	Description	Use
L_{max}	The maximum A-weighted noise level occurring during an identifiable intrusive noise event.	Characterizes a single noise source (truck, airplane, transit car)
L_{10}	The sound level exceeded only 10% of a specified time.	Gives a good description of a typical average of a number of peak noise events. Used by FHWA for describing highway noise.
L_{50}	The sound level exceeded during 50% of a specified time.	Describes the median sound level, or the sound level which is exceeded for half of the time.
L_{90}	The sound level exceeded during 90% of a specified time.	Characterizes the background sound level.
$L_{eq}(n)$	The equivalent sound level, or the steady noise level that would convey the same noise energy as the actual time-varying noise at a site in the same time period. Time period is specified by n hours.	Expresses noise exposure during a specified time period, n. Common usage is made of $L_{eq(1)}$, $L_{eq(8)}$, and $L_{eq(24)}$. Variations include L9 which refers to the L_{eq} during the 15 daytime hours from 0700 to 2200, and L_n or L_{eq} during the 9 nighttime hours from 2200 to 0700.
L_{dn}	The day-night sound level; the 24-hour average sound level with a 10_{dB} penalty applied to noise levels during the 9 nighttime hours from 2200 to 0700.	Used in community noise assessments; proposed by U.S. EPA for use in environmental impact statements.

Human Reaction to Environmental Noise

The effects of noise on people can be listed in three general categories all of which are interrelated:

1. Subjective effects of annoyance, nuisance and dissatisfaction;

2. Interference with activities such as sleep, speech and learning;

3. Physiological effects such as being startled, loss of hearing.

The sound levels associated with environmental noise, in almost every case, produce effects only in the first two categories. The U.S. Environmental Protection Agency has conducted a great deal of recent investigation in an effort to develop a completely satisfactory measure of the subject effectors on noise and the corresponding reactions of annoyance or dissatisfaction. The problem is complex due to the wide variation in individual thresholds of annoyance and the fact that individual past experiences develop different habituations to noise. Depending on their socio-economic status, political cohesiveness and other social variables, whole groups of people may vary in their response to noise.

The EPA study shows, however, that taken on a national average basis for residential locations, the average response of groups of people can be related to their cumulative noise exposure and can be expressed in a measure such as L_{dn}. For noise impact assessment purposes, it can be assumed that people have a generally adverse reaction to noise. The factors which contribute to this reaction are all related to the disturbance of essential daily activities; speech interference; interference with listening to radio, TV and stereo; and disturbance of a restful, quiet environment. To interpret such response as an adverse reaction, the percentage of people in the population that are highly annoyed by specified levels of noise must be determined.

The expected community reaction to a new noise source is important to the assessment of the noise impact of the Red Line Extension. Information from additional studies demonstrates that the general tendency of community reaction and individual annoyance is directly related to the Day-Night sound level of intrusive noise in a neighborhood. For assessing annoyance caused by noise specifically from rail vehicles, one recommended

measure which best correlates noise level with expressed annoyance is the equivalent sound level (L_{eq}) which takes into account both the maximum A-weighted noise level during train passages and the traffic volume. Surveys of attitudes toward noise have identified single noisy events as the main cause of annoyance and a number of studies have determined that repetition of single noisy events does not lessen their impacts.

Although absolute sound levels are important in determining the impact of noise on human activities, another important parameter in determining a person's subjective reaction to a new noise is the existing noise environment to which he has adapted--the so-called "ambient" noise. In general, the more the new noise exceeds the previously existing ambient, the less acceptable the new noise will be judged.

The following relationships will be helpful in understanding the effects of increases in noise levels:

1. Except in carefully controlled laboratory experiments, an increase of only one dB in A-weighted sound level cannot be perceived.

2. Outside of the laboratory, a three dB increase in A-level is considered a just-noticeable difference.

3. A change in A-level of at least five dB is required before any noticeable change in community response would be expected.

4. A fifteen dB increase in A-level would almost certainly cause an adverse community reaction.

Effects of Noise on Wildlife

There is very little well-documented information dealing with the effects of noise on wildlife, although it is reasonable to expect that excessive continuous noise will cause animals to migrate away from the source. Documentation exists on the interference with breeding habits of some animals due to aircraft overflights and other excessive noise events at critical times. Experience shows that loud noises do indeed frighten animals, although the basis for fright may be that the noise represents a source of danger to them. Taking flight under these circumstances is a normal defense mechanism. No documentation exists at present as to the

noise levels which interfere with natural animal activities and hence, it is inappropriate to set criteria levels for the effect of transit noise on wildlife.

Noise Assessment Method

One of the important functions of noise impact assessment is to determine the expected change in noise impact due to construction and operation of the transit system and to state how the exposed population will be affected by the new noise source. Two assessments are required:

1. Relative assessment, or how the noise environment will change due to the introduction of the new transit system.

2. Absolute assessment, or how the new noise environment compares with criterion levels, above which public health and welfare are degraded.

To date, there are no applicable regulations on any level of government which control or restrict noise and vibration levels of transit systems. All quantitative limits on noise and vibration are therefore in the form of guidelines and criteria.

A comprehensive set of noise and vibration criteria is recommended by the American Public Transit Association (APTA) in their current draft (1976). These proposed standards are a revision and enlargement of the 1973 guidelines on noise and vibration by APTA's predecessor, the Institute of Rapid Transit (IRT).

The MBTA has expressed the desire to use the latest APTA criteria wherever applicable. Consequently, tunnel and station designers involved in pre-grant engineering (Harvard Square to Alewife Station) have developed noise and vibration criteria using APTA guidelines.

"Design Criteria Reports" have been prepared for individual stations at Harvard, Porter and Davis Squares and Alewife Brook and the deep bore and cut-and-cover tunnel sections. Similar criteria will be developed for the Arlington Stations and tunnel. The noise and vibration sections of the "Design Criteria Reports" for the Alewife Station and the deep bore tunnel sections are included in this Appendix D as examples of progressing efforts to refine design parameters.

The data shown in Tables D-1 and D-2 are updated and expanded in the current "Design Criteria Reports" to reflect the latest APTA guidelines.

TABLE D-2

NOISE CRITERIA FOR TRAIN OPERATIONS*

Area Category	Transient Noise Level Criteria
1. Quiet Residential	70 dBA
2. Average Residential	75 dBA
3. Busy Residential/Semi-Commercial	80 dBA
4. Commercial/Open	85 dBA

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*These criteria are generally referenced to a point 50 feet from track centerline. In cases where buildings or occupied areas are further from the transit line, the criteria may be referenced to the building or area being considered.

In defining community noise levels, the urban or suburban areas may conveniently be considered in four general categories according to ambient sound levels at night as shown in Table D-3.

TABLE D-3

TYPICAL COMMUNITY AMBIENT NOISE LEVELS

Area Category	Area Descriptions	Ambient Noise Levels at Night
1	Quiet urban residential, open space park, suburban residential or recreational area. No nearby highways or boulevards.	30-40 dBA
2	Average urban residential, quiet apartments and hotels, open space, suburban residential, or occupied outdoor area near busy streets.	40-45 dBA
3	Busy urban residential, average semi-residential/commercial areas.	45-55 dBA
4	Commercial areas with office buildings, retail stores, etc., with daytime occupancy only. Open space parks, suburban areas near highways or high speed boulevards, distant residential buildings.	Over 55 dBA

CONSTRUCTION NOISE ABATEMENT

Minimization of construction noise in sensitive areas requires consideration of best available equipment during the construction planning stage. Such consideration includes a well-written set of noise specifications for subsequent inclusion in construction documents. The criteria would be met by requiring all construction contractors to prepare and comply with a Construction Noise Abatement Plan. Such plans incorporate the use of quieted equipment, care in locating and scheduling activities, selection of quiet construction techniques, selective routing of heavy trucks to avoid quiet residential streets, etc.

Examples of quieted machinery available to contractors are shown in Table D-4.

Construction noise criteria and discussion of construction related noise is further discussed in the design criteria examples included in this Appendix.

Construction Vibrations

Groundborne vibrations from piledrivers especially, but also from other heavy equipment operating close to buildings, can be impactive. Piledriving operations would occur primarily in cut-and-cover construction areas. At sensitive locations such as Harvard Square, Davis Square and portions of the cut-and-cover tunnel west of Davis Square, "softer" techniques are under consideration. Piles would be dropped in pre-bored holes with only a minimum of driving to properly seat the pile tips. Indications are that sheeting, in most instances, can be placed using vibratory methods in lieu of impact driving. In several areas of cut-and-cover construction slurry wall techniques will supplant traditional piling and lagging methods.

Example of Construction Noise Abatement

An example of the effectiveness of employing quieted machinery is worked out for the Harvard Square area.

TABLE D-4

RESULT OF NOISE MUFFLERS AND ACOUSTICAL ENCLOSURES ON CONSTRUCTION EQUIPMENTS AND TOOLS AND TOOLS NOW IN USE (PARTIAL LIST)[1]

Equipment	Device	Before	After	Distance
Pile Driver Vulcan 010	none	103dBA		25 ft.
	muffler on exh. and sound barrier on the leads		85dBA	25 ft.
Paving Breaker Ingersall-Rand Model SB-8	none	105dBA		3 ft.
	muffled		100dBA	3 ft.
	muffled		85dBA	50 ft.
	plus acous. enclosure		75dBA	35 ft.
Diesel Drive Electric Welding Machine Lincoln Co. Model 400	none	93dBA		23 ft.
	muffler and plus acous. enclosure		76dBA	23 ft.
Air Compressor - (Diesel Driven) Ingersall-Rand 1200 CFM	none	105dBA		3 ft.
	muffled		85dBA	3 ft.
Gardner-Denver 750 CFM	none	103dBA		3 ft.
	muffled		85dBA	3 ft.

TABLE D-4 (Continued)

Equipment	Device	Before	After	Distance
Air-tracked Drill				
Ingersall-Rand				
600 CFM	none	104dBA		23 ft.
	acous. enclosure		83dBA	23 ft.
Gardner-Denver	none	104dBA		23 ft.
	muffled		100dBA	23 ft.
	plus acous. enclosure		77dBA	23 ft.
Chain Saw				
Gasoline Driven	none	113dBA		3 ft.
Elec. Driven	none	86dBA		3 ft.
		72dBA		15 ft.

Construction Noise in Harvard Square

The proposed project has been evaluated for noise impact due to cut-and-cover construction activity in the Harvard Square area. Each was examined for a "noisy case" and a "quiet case". The "noise case" incorporates the use of typical machinery now on the market. The "quiet case" incorporates the use of the quietest ten percent of machinery now on the market.

The following is a summary of the phases considered for the proposed project:

Phase 1: Cut-and-cover work to construct a temporary station at Massachusetts Avenue between Dunster and Holyoke Streets

Phase 2: Cut-and-cover work for a new bus tunnel west of the existing tunnel between Flagstaff Park and Harvard Coop

Phase 3: Cut-and-cover construction of a new station and tunnel on Massachusetts and Peabody Street from Lehman Hall to Hemenway Gym

Phase 4: Cut-and-cover work to connect to existing tunnel in Harvard Square

In calculating the total Equivalent A-weighted Sound Level, L_{eq}, for an eight hour day (L_{eq}) which can be expected during each construction phase, the following assumptions were made. Generally, construction during each phase was assumed to consist of six sub-phases. A description of these subphases can be found in Table D-5. A similar construction method has been used to construct some portions of the existing Boston Subway (Grand, 1973). Each phase was assumed to be a line source measuring the length of each phase over which the sound power resulting from the construction activity was distributed.

The equipment usage factors for each subphase reflect the number of different types of machinery in use and the period of time each was at or near its noisiest mode of operation. Table D-6 is a summary of equipment and associated usage factors. Shielding of some equipment due to operation beneath the temporary road deck was also considered and re-

flected in the usage factors.

The sound intensity was subsequently calculated along the perpendicular bisector of each line source for each subphase. Where both temporal and spacial considerations were concurrent for subphases of two different phases, overlapping of construction activities was considered to have occurred. Hence, the intensities resulting from each of these subphases were combined to yield a level representative of two types of construction occurring at the same place and the same time. It should be noted that in using the intensities along the perpendicular bisectors of the line sources, one considers the "worst case" exposure to construction noise.

From the above, the Equivalent A-weighted Sound Level L_{eq} was calculated for an eight-hour work day (assuming no nighttime construction activity). Impact was determined through the comparison of the construction activity L_{eq} predictions for each phase and the measured ambient.

Here, impact is defined as the amount which has L_{eq} (eight hours) raised above the ambient. The criterion used and a definition of the degree of impact can be found on pages D-17 and D-18, Appendix D.

From measurements taken of the ambient noise in the Harvard Square area, it was found generally that buildings have a facade on a major road (Massachusetts Avenue, Peabody Street, Mount Auburn Street, Boylston Street, Brattle Street) are currently exposed to an L_{eq} of $\gtrsim$ 70dBA during the eight-hour workday. Those areas not on major road or shielded from major roads by other buildings are currently exposed to an L_{eq} of $\gtrsim$ 60dBA during the eight-hour workday.

Table D-7 is an evaluation of impact for noisy and quiet cases for the proposed line. Each entry indicates some type of construction activity. The entires are in two parts. The symbol on the left indicates the degree of impact at the facade of the buildings nearest the construction activity. To the right of the symbol is the depth of the impact zone measured in feet. Here, impact zone is defined as the region which experiences at least some degree of impact due to construction activity, where the ambient had been assumed or measured to be an L_{eq} (eight hours) of 60dBA. Thus, at the indicated distance, one finds a transition from Severe Impact to None as one moves away from the construction site.

TABLE D-5

PHASE CUT AND COVER CONSTRUCTION SCHEDULE

Subphase Number	Duration % of Total	Description
1	15	Preparation of Site Removal of Pavement/Side-walk Removal of Road Surface Excavation of Top Soil Preparation of Shallow Trench Piling and Casting of Concrete Guide Walls Construction of Slurry Walls
2	5	Positioning of Temporary Road Deck
3	10	Bracing of Retaining Walls Further Excavation
4	48	Construction of Concrete Formwork Pouring of Concrete
5	11	Removal of Temporary Road Deck Backfilling
6	11	Reinstatement of Permanent Road Surface

TABLE D-6

EQUIPMENT USAGE FACTORS*

Equipment	Construction Subphase Number					
	1	2	3	4	5	6
Dozer	2.6	-	10	-	25	-
Compactors	-	-	-	-	-	20
Loaders	6.8	5	15	-	5	-
Backhoes	11.3	-	25	-	25	-
Tractors	2.6	-	10	-	25	-
Graders	-	-	-	-	-	20
Pavers	-	-	-	-	-	30
Trucks	17.3	10	10	20	10	10
Concrete Mixers	13.2	-	-	15	-	-
Concrete Pumps	13.2	-	-	15	-	-
Cranes	35.5	30	10	20	30	-
Pumps	17.4	-	-	5	-	-
Generators	-	5	5	5	-	-
Compressors	14.7	10	-	-	10	10
Bar Benders	-	5	5	10	-	-
Jack Hammers	14.7	5	-	-	5	5
Pile Drivers	4.7	-	-	-	-	-
Vibrators	-	-	-	5	-	-
Chain Saws	-	-	5	5	-	-

*Usage factors for each phase represent percentage of time in operation at or near noisiest mode.

TABLE D-7

CONSTRUCTION NOISE IMPACT FOR ALIGNMENT D2

Month after Start of Construction	STANDARD CONSTRUCTION EQUIPMENT PHASE 1	2	3	4	QUIETEST 10% OF PRESENTLY AVAILABLE CONSTRUCTION EQUIPMENT PHASE 1	2	3	4
1	550				230			
2	330	400			160	150		
3		200				100		
4		200				100		
5		200				100		
6		600	600			200	200	
7			400	700			200	300
8			400	400			200	200
9			400				100	
10			150				60	
11			150				60	
12			150				60	
13			150				80	
14			150				80	
15			150				80	
16			150				80	
17			150				80	
18			150				80	
19			150				80	
20			150				80	
21			150				80	
22			200				90	
23			330	330			200	200
24			330	330			200	200
25			330	330			200	200
26			400	400			200	200
27				370				200
								150

KEY: Degree of impact at facade of nearest building
None Some Significant Severe
Number denotes distance of impact zone (see text).

CONSTRUCTION NOISE CRITERIA

Based on considerations of increase and noise level, the following table applies to construction noise impacts.

Table D-8. Construction Noise Impact Criteria for Increase Over Existing Levels

Increase in Existing Eight-Hour Average Sound Level (L_{eq} (8 hour), dB)	Degree of Impact
Less than 5	None
5 - 10	Some
10 - 15	Significant
More than 15	Severe

In addition, consideration should be given to absolute noise levels from construction activities such that disturbance is minimized. One such set of criteria is suggested by the Construction Noise Specifications incorporated into construction documents of the New York City Transit Authority. These are reproduced below as an example of noise criteria which could be adopted during the construction phase.

Sound level for impulsive or impact noise (noise of duration less than one second) shall not exceed a peak sound pressure level of 140 dB when measured on an approved impact noise analyzer. In lieu of the above procedure, 125 dB measured on the C scale of a standard sound level meter at fast response will be accepted as an equivalent measure of peak sound pressure level.

Additional sound levels for noise due to construction will be measured at the street line of the structure adjacent to and along the area

of the Contractor's operations and plant. Sound levels measured at the street line shall not exceed the following:

Residential Structures:
Daily, except Saturday and Sunday, 7AM to 11:30PM-75dBA*
Daily, except Saturday and Sunday, 11PM to 7AM-60dBA*
11PM Friday to 7AM Monday-60dBA*

Business - Commercial Structures:
Daily, including Saturday and Sunday, all hours, a maximum of 85dBA*, unless otherwise permitted by the Engineer.

Factory - Commercial Structures:
Daily, including Saturday and Sunday, all hours, a maximum of 90dBA** unless otherwise permitted by the Engineer.

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*Measured on the A Scale of a General Purpose sound level meter at slow response.

**Measured on the A Scale of a General Purpose sound level meter (conforms to American National Standards Institute specifications 1.4-1961) at slow response.

EXAMPLE

Section 13 - Noise and Vibration

from

DESIGN CRITERIA REPORT

Red Line Extension

Harvard Square to Davis Square

September 1976

by

Bechtel Incorporated
Engineers and Constructors
Somerville, Massachusetts

SECTION 13

NOISE AND VIBRATION

13.1 Definitions

- Noise consists of pressure fluctuations in the audible frequency range 20-10,000 cycles per second (Hz), and measured in dBA, i.e. decibels with A-Weighting (Ref. 1).
- Air-borne Noise is noise that reaches the listener via the air such as train noise reaching street level through a vent shaft.
- Ground-borne Noise is noise that reaches the listener via the the ground such as train noise that may be audible as a rumbling sound inside the basement of a building over a tunnel.
- Ground-borne Vibration consists of small amplitude oscillations of solid objects, mainly in the frequency range between 0 and 100 Hz, such as barely feelable ground movement as a train passes through a tunnel underneath.
- Construction Noise and Vibration are short term effects during system construction and/or major maintenance.
- Operations Noise and Vibration are long-term effects due to system operation.
- Continuous Noise means noise that fluctuates less than ±3 dBA over a period of one hour such as sound from ventilating fans or transformers.

- Transient Noise Level means the maximum noise level during a train passage as measured with a standard sound level meter set to slow meter response (Ref. 1).

13.2 Air-borne Noise

Air-borne noise due to operations emanating from vent shafts or elsewhere shall not exceed the exterior (outdoors) noise levels shown in Table 13-1. These criteria are based on proposed APTA Standards (Ref. 2), the draft EAR (Ref. 3), and U.S. EPA information (Ref. 4). The criteria will be met by a combination of facility siting and noise control design.

TABLE 13-1 OPERATIONS NOISE: MAXIMUM AIR-BORNE NOISE LEVELS OUTDOORS IN dBA WITH METER ON SLOW RESPONSE (Ref. 1).

LAND USE	TRANSIENT NOISE (Trains)	CONTINUOUS NOISE (Excluding Transformer Hum)	TRANSFORMER HUM
(A) Residential, School, Library, Church, Park, and All Other Noise Sensitive Uses Not Listed in (B).	65 dBA	50 dBA	45 dBA
(B) Public Streets or Sidewalk, Commercial or Industrial	72 dBA	60 dBA	55 dBA

Air-borne noise due to construction shall not exceed the exterior (outdoors) noise levels shown in Table 13-2 These criteria are based on a 10 dBA increase in ambient levels and other criteria reported in the EAR (Ref. 3). The criteria will be met by requiring all construction contractors to prepare and comply with a Construction Noise Abatement Plan. Such plans incorporate the use of specially muffled equipment as necessary, care in locating and scheduling activities, selection of quiet techniques of construction, etc. Use of existing railroads to remove tunnel spoil rather than trucks on surface streets can contribute significantly to construction noise abatement.

TABLE 13-2 CONSTRUCTION NOISE: MAXIMUM AIR-BORNE NOISE LEVELS OUTDOORS: TEN-PERCENTILE (L10) IN dBA.

LAND USE	DAYTIME (7am-10pm)	NIGHT-TIME (10pm-7am)
(A) Residential, School, Library, Church, Park, and All Other Noise Sensitive Spaces Not Listed in (B).	75 dBA-L10	65 dBA-L10
(B) Public Streets or Sidewalk, Commercial or Industrial	85 dBA-L10	75 dBA-L10

13.3 Ground-borne Noise

Ground-borne noise levels due to trains passing shall not

exceed the levels shown in Table 13-3. These criteria are based on proposed APTA Standards (Ref. 2) and consideration of typical noise levels in various types of building space (Ref. 5). The criteria will be met by a combination of design features possibly including tunnel structure and track structure, i.e. rail, fastener and supporting elements. There may possibly be a need for relocation or construction modification of a small number of buildings or spaces.

TABLE 13-3 OPERATIONS NOISE: MAXIMUM GROUND-BORNE NOISE INDOORS IN DBA WITH METER ON SLOW RESPONSE (Ref. 1).

BUILDING/SPACE TYPE	MAXIMUM TRAIN NOISE
(A) Residential, School, Library Church, and All Other Noise Sensitive Spaces Not Listed in (B) or (C).	35 dBA
(B) Hotel/Motel Sleeping Quarters.	40 dBA
(C) Commercial, Office and Industrial.	45 dBA

Ground-borne noise from construction activity shall not exceed the levels shown in Table 13-4. The night-time criteria are 5 dBA higher than the train pass-by criteria in Table 13-3. The daytime criteria are 10 dBA above the night-time criteria. These criteria will be met by compliance with a contractor Construction Noise Abatement

Plan as described in Section 13.2.

TABLE 13-4. CONSTRUCTION NOISE: MAXIMUM GROUND-BORNE NOISE INDOORS: TEN-PERCENTILE (L10) IN DBA.

	BUILDING/SPACE TYPE	DAYTIME (7am-10pm)	NIGHT-TIME (10pm-7am)
(A)	Residential, School, Library, Church and All Other Noise Sensitive Spaces Not Listed in (B) or (C).	50 dBA-L10	40 dBA-L10
(B)	Hotel/Motel Sleeping Quarters	55 dBA-L10	45 dBA-L10
(C)	Commercial, Office and Industrial.	60 dBA-L10	50 dBA-L10

13.4 Ground-borne Vibration

Ground-borne vibration in occupied spaces in any building not owned by MBTA when measured in the vertical direction at or immediately next to any foundation footing or structural column shall not exceed the following limits expressed in terms of R.M.S. Acceleration: Octave Band Levels in dB re 1 micro-G (0.001 cm/sec/sec).

TABLE 13-5

PERMISSIBLE GROUND-BORNE VIBRATION (dB re 1 micro-G)

Octave Band Center Frequency (Hz)	4	8	16	32	63	125	250
Due to Train Operations	60	60	64	64	68	74	86
Due to Const. Activity	75	80	85	90	95	100	105

The above criteria are consistent with the proposed APTA Standards (Ref. 2). For Train Operations the above criteria are thresholds of human perception according to Ref. 7. For Construction Activity the above criteria are in the "strongly perceptible" range but well below levels that present risk of damage to residential or other buildings. (Ref. 8).

For Ground-borne Vibrations from Train Operations, criteria will be met by a combination of design features possible including tunnel structure and track structure, i.e. rail, fastener, and supporting elements.

The Construction Activity criteria will be met by compliance with a Construction Noise Abatement Plan as described in Section 13.2. There may possibly be a need for relocation or construction modification of a small number of buildings or spaces.

13.5 References

1. Specification for Sound Level Meters, ANSI S1-4-1971, (American National Standards Institute Inc., New York, 1971).

2. Proposed APTA Standards, Division 2.8 Noise and Vibration, (American Public Transit Association, 1976).

3. Environmental Analysis Report: Red Line Extension, (MBTA, February 1976).

4. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, (U.S. EPA Report 550/9-74-004, March 1974).

5. Noise and Vibration Control, L.L. Beranek, editor, (McGraw Hill Book Co. Inc., New York, 1971).

6. The Effects of Shock and Vibration on Man, Report S3-2-39 (American National Standards Institute, New York).

7. T. Miwa, "Evaluation Methods for Vibration Effect - Part 8 - The Vibration Greatness of Random Waves", Ind. Health 7: 89-115 (1969).

8. J. Wiss, "Vibrations During Construction Operations" ASCE J. Construction Div. CO3:239-246 (1974).

EXAMPLE

Chapter 7 - Acoustics, Noise, and Vibration

from

DESIGN CRITERIA REPORT

Red Line Extension

Alewife MBTA Station/Garage

September 1976

by

Wallace, Floyd, Ellenzweig, Moore, Inc.
Architects/Planners

Chapter 7 Acoustics, Noise, and Vibration

The criteria for noise, vibrations, acoustical quality, and paging system performance which we plan to use as the basis for the schematic and final design phases of the Alewife Station have been tentatively selected. For a system-wide approach, these criteria are subject to review with the consultants to the other Red Line Extension station architects and final approval by the Authority. The basic design approaches which are available to meet the various criteria are briefly reviewed. Limitations on the performance of the overall project imposed by special noise and vibration control materials are listed. The influence of existing site characteristics and of potential future developments in the vicinity are discussed. Specific means of meeting the chosen criteria will be developed in the Schematic Design phase.

Applicable Guidelines and Jurisdictional Requirements

At this time there are no applicable regulations on any level of government restricting noise and vibrations of transit systems. All quantitative limits on noise and vibration are therefore in the form of guidelines and criteria. One should keep in mind that the industrial noise exposure regulations of the Occupational Safety and Health Administration (OSHA) of the Federal Department of Labor may be adopted by the Commonwealth in the near future (State Senate Bill 311). Hence all public employees including those of the MBTA would be covered by the current 90 dB(A) per eight hour day noise exposure limit. Noise levels measured inside current MBTA rolling stock and in stations indicate that the OSHA noise exposure limits can be met for personnel in stations as well as for train operators. Future equipment and stations are expected to be considerably quieter. Reductions of the current OSHA exposure limits are under study and may eventually be legislated, however, quieter future equipment and the use of station noise control materials are expected to prevent violations of the stricter limits.

The Commonwealth has a nuisance noise regulation which is actively administered by the Division of Air Quality Control (Al Comproni, 727-2658) of the Department of Environmental Quality Engineering of the Executive Office of Environmental Affairs. Continuous noise emissions of any facility is considered excessive if more than 10 dB(A) above the background noise (without facility operating) at the facility's property line or the nearest inhabited building.

CURRENT OSHA NOISE EXPOSURE LIMITS

Duration per day, hours	*Sound level dBA slow response*
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

[1] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions $C1/T1 + C2/T2$ Cn/Tn exceeds unity, then, the mixed exposure should be considered to exceed the limit value Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

A facility may be exempt if, even after the application of the "best available technology", noise is still excessive. In the context of the Alewife Station these regulations apply only to stationary continuous noise sources such as the Traction Substation and Station ventilation equipment.

APTA GUIDELINES

A comprehensive set of noise and vibration criteria are recommended by the American Public Transit Association (APTA) in their current draft (Ref. 7.7), a revision and enlargement of the 1973 guidelines on noise and vibration (Ref. 7.6) by its predecessor, the Institute of Rapid Transit (IRT). At the meeting of 17 August 1976 at Bechtel's offices, the Authority expressed the desire to use the draft APTA criteria wherever applicable (meeting notes dated 19 August 1976 by Jane Weinzapfel of WFEM). The noise and reverberation time goals appropriate to the Alewife Station have been excerpted and are listed in Table 7A.

TABLE 7A: Platform Noise Level and Acoustics

Trains Entering and Leaving	80-85 dB(A)
Trains Passing Through	85 dB(A)
Trains Stationary (15 ft. or more from train*)	68 dB(A)
Door Operations and Other Transient Noises of Trains at 1 ft. from Side of Train*	72 dB(A)
No Trains in Station (only ventilation system, escalators, etc. operating)	55 dB(A)
Inside Fare Collection and Starters Booths (no trains in station)	50 dB(A)
Reverberation Time (typical two track station)	1.2 to 1.4 sec.

*Wording of APTA draft modified to retain consistency with other APTA noise goals.

Functional Requirements and Criteria

STATION STRUCTURE VIBRATION CRITERIA

Station structural vibration levels in any area normally utilized by patrons and Authority employees should be limited although limits can be allowed to be higher than in residential and similar structures in the surrounding community. There is no corresponding APTA goal or criteria although there is an APTA goal for vibrations in rapid transit cars created by auzilliary equipment mounted on the cars. This vehicle vibration criterion is rather high for buildings being about 10 to 15 dB above the vibration perception threshold.

As a compromise goal we suggest a limit on structural acceleration of -50 dB re 1 G rms in any octave band from 2 Hz to 1000 Hz center frequency. This limit lies somewhat above the normal vibration perception threshold but is well below the International Organization for Standardization (ISO) Standard 2631 limit for "reduced comfort" for 8 hours per day exposure. Furthermore, the audible noise level in a

typical room whose floor or walls vibrate with these acceleration levels will be roughly equivalent to the APTA goal of 55 dB(A) recommended ambient for noise levels of transit station platforms. These various vibration criteria are shown in Fig. 7.A.

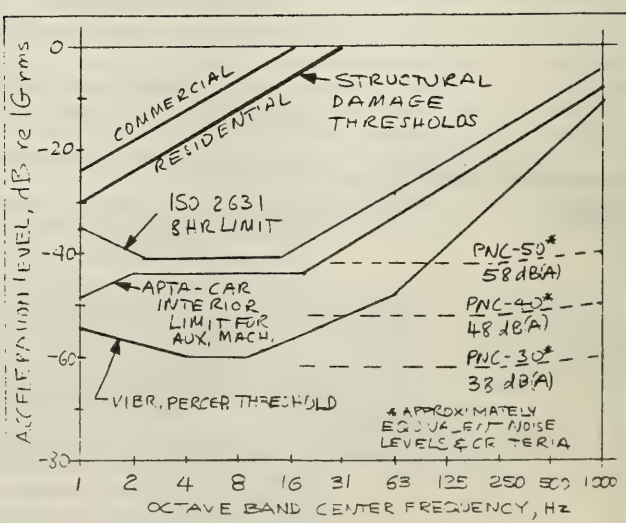
The equivalent noise level is based on a simple model of a large surface vibrating in phase and radiating plane waves into a free space. For this model the sound pressure is related to the surface acceleration by the following equation:

$$SPL = 150 + 20 \log \left(\frac{a}{f}\right) \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2$$

where a is the rms surface acceleration expressed in gravity units (1G = 386 in./sec.^{2} = 980 m./sec.^{2}) and f is the frequency of the vibration in Hertz (cycles/sec). A typical measured subway tunnel invert vibration during a train passage is 0.01 g rms, at 100 Hz, hence the train noise level in a building basement in close contact with the tunnel would be about 70 dB at 100 Hz. Noise in the tunnel would probably be much higher due to direct sound radiation from vibrating wheels, motors and car body, as well as aerodynamic noise of the train traveling in the 40 to 60 mph range.

The airborne noise produced by structural vibrations is often found to be much higher than predicted by the formula above. The reason is that most buildings, particularly

FIG. 7.A: VARIOUS CRITERIA FOR VIBRATION EXPOSURE



lightweight framed structures such as wooden residential houses, walls and floors exhibit resonances which are excited by the incoming vibrations. Occasionally loose windows and furnishings contribute to the audible noise even at frequencies much higher than those of the vibrations as a result of the non-linear motions of such elements. In such cases the measured noise level can be as much as 20 dB higher than the predicted value. This is especially true at frequencies below 250 Hz where such structural resonances are most likely to occur and where attenuation of vibrations by structures and the soil is minimum. For typical station structures their inherent rigidity and absence of loose furnishings and equipment the noise enhancement effect by resonances described above need not be a major concern. It must be considered however in the prediction of noise in wood frame residential and other noise sensitive buildings of lightweight construction in the surrounding community.

STRUCTURAL DAMAGE CRITERIA

Structural damage criteria for building vibrations allow considerably greater amplitudes of vibration. One criterion for damage threshold (Ref. 7.16) is stated in terms of peak velocity independent of frequency as follows:

Residential Structures - 2 in/sec

Commercial Type buildings - 4 in/sec

Note that these vibration limits are at least 100 times higher than measured subway tunnel vibration data in our files (Ref's. 7.8, 7.17, 7.18, 7.19, 7.20).

The acoustical quality of station spaces is controlled by the geometry and the sound absorbing materials built in or attached to the structure. The extremes of subjective impressions of the acoustical quality of a space are usually indicated by the prophylactic descriptions, live and dead. Occasionally unique geometric features of spaces lead to additional, normally negative, comments about echoes. Public circulation spaces that do not serve as auditoria and where people do not spend long periods of time should, in our opinion, be allowed to be moderately reverberant (i.e. live). To permit reasonably intelligible paging system performance, however, the reverberation can not be excessive. In addition, the geometry of the station and the orientation of the paging system speaker beam patterns must be must be designed to avoid long delayed echoes. The speakers must also achieve reasonable uniformity of the electronically reinforced speech sound level in the patron areas of the platforms.

Besides a range of acceptable reverberation times listed above, the APTA guidelines recommend coverage of about 30 percent of platform walls and ceilings in addition to all platform overhang surfaces.

The acoustical treatment criteria for the MARTA (Atlanta) transit system (Ref. 7.3) developed by consultant George Wilson of Wilson-Ihrig and Associates, Inc. of Oakland California, who also was a major contributor to the APTA guidelines, also provides for 30 percent acoustical treatment of stairwells, corridors and mezzanine areas. While these amounts of acoustical treatment would not produce an excessively dead environment in an otherwise hard finished space the treatment may not be necessary.

The use of reverberation time as an acoustical criterion for stations is imprecise and can be misleading since station spaces are typically tube shaped or at least of shallow aspect. The reverberation time concept is applicable to spaces whose proportions are less extreme. Secondly, the reverberation time describes the decay of sound, assumed to occur uniformly, over a 60 dB range whereas only the initial decay of 10 to 15 dB from the peak sound level is really of interest to speech intelligibility. In duct-like spaces such as station platforms the initial decay rate is usually different from the average decay rate over the 60 dB range. In wide, low ceiling platforms the initial rate depends also on the sound source location with respect to the walls of the space and the tunnel portals.

Rather than reverberation time as a criterion a limit on the initial decay rate over the paging system frequency range would be more precise. A minimum initial decay of 3 dB in 60 milliseconds would be satisfactory for high speech intelligibility. The equivalent linear decay is 50 dB/second. For normally proportioned rooms this rate would result in a reverberation time of 1.2 seconds. Since computation of the initial decay rate is difficult we do not recommend it as a criterion but rather as a reminder for the acoustical consultant to make certain that the acoustical design permits good speech intelligibility without degredation of speech privacy and without creating an overly dead space.

The indiscriminate application of acoustical material should be discouraged. The principal benefit of sound absorbing treatments is in the control of excessive noise exposure of patrons and employees. Since the most vulnerable receptors are the patrons closest to the tracks, the only way to obtain a significant reduction in train noise exposure at these locations is to treat the surfaces closest to the train particularily near the wheels, i.e. the station ceiling and walls nearest the track, all available areas of the platofrm overhang and the tunnel surfaces within 200 to 300 ft. of the station. Where small radius curves exist within 200 ft. or so of a station the tunnel treatment

should extend from the portal to the termination of the curved track section.

The treatment of the whole platform ceiling near the tunnel portals can be justified for some stations especially those having little or no through (express) trains. The train speed, hence its noise output, is greatest nearest the ends of the platform during arrival and departure. For those stations that are much longer than the typical train patrons concentrate in the train stopping area. Hence their noise exposure could be reduced by treating any sound reflecting surfaces that lie between them and the high speed portions of the station. Train noise in stations can also be reduced by blocking off any areas between the track and the platform not required for train access by patrons and operating personnel. The simplest embodiment of this approach would be a solid vertical baffle extending from the station ceiling to car door height at the edge of the platform. The train side of such a baffle should be highly sound absorptive. Tunnel noise especially if curves or switches and crossovers are located just beyond a station can also be reduced somewhat by keeping the portal openings to a minimum.

Once the train noise levels at the most vulnerable locations on the platform have been reduced to the APTA goal of 80 to 85 dB(A) there is no advantage to providing additional noise reduction obtainable at greater distances by blanketing the whole station with sound absorbers. Under normal circumstances train noise is highest at the edge of the platform.

Depending on the station geometry entrance lobbies, stairwells, pedestrian tunnels and the central portion of very wide platforms should receive little or no acoustical treatment, except where needed to improve paging system intelligibility.

Another disadvantage to an acoustically dead public space, especially one that exhibits an extremely low background noise, is the lack of acoustical privacy that may be desired by patrons who do not wish to have a conversation with a companion overheard. Thus, not only should acoustical treatment be limited but a moderate amount of background noise of an unobtrusive character should be encouraged to provide speech masking during periods of train inactivity. Available noise sources include escalators and particularily ventilation machinery.

The tables containing the acoustical design goals for all types of garage and station spaces are located in Table 7.B. These design goals for acoustical treatment, noise isolation, background noise, and vibration control were based in part on the APTA guidelines and more extensively on the experience of our firm with acoustical design for similar spaces. Most of the criteria used in the acoustical consulting

TABLE 7.B: General Design Criteria for Acoustics, Noise and Vibration Control for Alewife Garage and Station Spaces

Location	Space	Geometric Considerations	Acoustical Treatment	Sound Transmission	Vibrations, Structure Borne Noise	Ambient Noise Limits dB(A)	Remarks
A. Parking Garage	1-Fee Collection	N/A	.60 NRC[1] Ceiling	NIC[2]≥30 To Outside (Except for Voice Comm.)	N/A	≤45 w/o Intercom; ≤50 with	Face to Quiet Area
	2-Elevator Lobbies	N/A	.60 NRC Ceiling if paging system or in noisy area (≥80 dBA L_{10}[3])	N/A	N/A	N/A	
	3-Parking Stalls & Walkways	Provide barriers if L_{10}≥80 dB(A) for any hour	None	N/A	N/A	$<80L_{10}$ $<70L_{90}$[3]	
	4-Telephone Booths or Stalls	N/A	High Absorption to Reduce Noise to <60 dB(A) L_{10}	NIC ≥30 if a booth (less acoustical material required)	N/A	≤55 L_{50}[3] if booths	Locate in Quiet Area or Shield if open Stall
	5-Office(s)	N/A	.60 NRC Ceiling	NIC ≥35 to adjacent area	Avoid Loc's Contiguous with ramps	≤50 db(A)	--
B. Transfer Level	1-Waiting Area	Minimum Exposure to Bus & Highway Noise	.60 NRC CLG if Paging System	N/A	N/A	See A.3	--
	2-Operating Personnel Locker/Lunch Offices/ Porter	N/A	.60 AC CLG	NIC ≥35 to Outside Areas	Avoid Location Next to Ramps	≤50	--
	3-Commercial Space	NOT IN CONTRACT (ISOLATE FROM BUS AND HIGHWAY NOISE)					
C. Station Mezzanine & East Entrance	1-Fare Collection Booths	N/A	.60 NRC Ceiling	NIC ≥20 to Station Mezz (Except for Voice Comm.)	Avoid Location Under Ramps or Next to Mech. Spaces	≤50	Consider Need for communication with patrons (large opening)
	2-Main Space	No Large Concave and Hard Parallel Surfaces if possible	None, unless needed to make paging system work	NIC ≥20 to Bus Area (Doors?)	Train Vibration control (See D.3)	>55 <45	--
	3-Telephone Booths			(SEE A.4 ABOVE)			
	4-Concessions	N/A	None (See C.2)	N/A If Open	(See Above C.2)	<55	--
	5-Employee Locker Rooms Porter's Room			(SEE B.2 ABOVE)			

TABLE 7.B: General Design Criteria for Acoustics, Noise and Vibration Control for Alewife Garage and Station Spaces (Continued)

Location	Space	Geometric Considerations	Acoustical Treatment	Sound Transmission	Vibrations, Structure Borne Noise	Ambient Noise Limits dB(A)	Remarks
C. Station Mezzanine & East Ent. Continued	6-Toilets Employee and Public	N/A	(None Practical)	≥45 to Adj. occupied spaces	N/A	<55 >45	Return Air Path & Exhaust Duct Sound Transfer Problems
	7-Fan & Mech. & Elec. Equpt. Rooms, etc. (Anywhere in Station; see E below for outside facilities)	N/A	None unless I/C engine or other "loud" [>80 dB(A)] Equipment	NIC to meet ambient criteria of adjacent spaces	Vibration Isolation may be required to meet ambient criteria	≤80 dBA @ 3 ft. or equal for most equipment	Door Gaskets if >80 dB(A) or critical adjacency; outside louvers must meet community noise criteria
D. Station Platform	1-Stairwells & Escalators & Elevators	See C.2 Above	See C.2	N/A	N/A	<55 >45	Specify Escalator noise & vibration not to exceed HVAC ambient & no pure tones or rattles
	2-Platform	See C.2 Above	Strategic Locations to be studied in schematic design phase	N/A Except to Tunnel & Curved Sections to be studied	To be Studied - Adjacent land use plans critical	<55 >45 w/o Trains <85 with Trains (peak) see Phase II Report	Paging System Design Critica
E. Outside Ancillary Facilities	1-Traction Substation & XFR Substation	Face Louvers and other noise escape openings from public areas	As required to meet community & A.3 Garage Criteria				Consider Lower Noise criteria for pure tones (hum). I/C Engine equip't requires mufflers, air silencers, etc

Footnotes:

[1] NRC - Noise Reduction Coefficient, an average value of absorption coefficients for acoustical materials, e.g. most mineral board acoustical lay-in panels have an NRC of .50 to .65.

[2] NIC - Noise Isolation Class - a single number rating for the noise level difference between any two rooms produced by a noise source in one of them.

[3] L_{10}, L_{90}, L_{50} - noise levels exceeded, 10, 90 and 50 percent of the time, a measure of fluctuating noises such as traffic.

practice are published, but scattered among a variety of textbooks, standards, building codes, and guideline specifications by government agencies. The basic principles underlying the acoustical design goals are

1. Maximum background noise levels must meet APTA guidelines however, a minimum is needed to mask intrusive noise in order to reduce the need for high noise isolation construction between certain spaces e.g. toilets.

2. Overall noise isolation class (NIC) requirements between spaces are based on the difference between the maximum anticipated noise levels in the noisier space and the average anticipated ambient level in the quieter space.

3. Acoustical treatment is suggested only where too many hard surfaces are likely to cause excessive reverberation or echoes that reduce speech intelligibility, e.g. on station platform end walls. It may also be needed where shielding of a noisy area from a quieter one will be impaired by reflections from such surfaces, e.g. bus patron waiting areas and open telephone booths.

4. Vibration problems in areas requiring relatively quiet conditions, e.g. offices, or those utilized for long periods by station personnel, e.g. change booths, is minimized by avoiding contiguity with mechanical equipment spaces, escalators, garage ramps and other facilities having potentially high vibration levels.

AMBIENT NOISE

The noise in the area surrounding the station site is currently dominated by traffic noise on Route 2 terminating in the Dewey and Almy rotary, the Alewife Brook Parkway running through the site and to a lesser extent Rindge Avenue. Occasional freight and commuter (Budliner) rail traffic occurs on tracks bordering the site. Stationary noise sources of relatively less importance are various components of the W. R. Grace Co. (formerly Dewey and Almy) plant. Recent short term noise samples have been obtained by other investigators for related environmental assessment studies (Red Line Extension EAR, 1975; and Alewife Brook Parkway Traffic Improvement Study, 1975). The results of these measurements are listed in Table 7.C. Since the ambient noise is so dominated by vehicular traffic on two to three roads that have essentially limited access it is obvious that the average ambient noise will decrease predictably with distance from and proportional to the traffic flow on these roads. Current and projected traffic data for these roads are being collected and should allow us to predict the ambient noise for critical periods of the day for which noise measurements were not available, but during which the station will be in operation. From these

estimates one can derive the degree of impact of station noises and to develop noise control measures should they be needed to minimize the intrusion on the existing residential areas to the east of the station, the recreational area (Russell Field) and future noise sensitive developments such as motels, apartments and parks.

As an example of the effect of Route 2 traffic noise on the area we have estimated the traffic noise on an hourly basis at 200 ft. from the edge of the highway. As input we used the actual traffic count, averaged over three weekdays June 2, 3 and 4, 1975, for which the peak hour traffic (both ways) is 4200 VPH and the ADT is 52,000, occurring between 7 and 9 AM and between 4 and 6 PM. The associated hourly L_{50} was calculated assuming 40 mph average speed and the corresponding L_{10} was estimated from existing noise data in our files on similar highway configurations.

The actual observed truck percentage during these peak hours is less than 2.5 percent, hence the truck noise contribution is not significant since documented truck counts were performed only on a sporadic basis the truck noise contribution could not be determined although it is suspected that during the early morning traffic lull between 2 and 6 AM (less than

TABLE 7.C: Measured Alewife Station Ambient Noise Levels (10 to 20 minute samples)

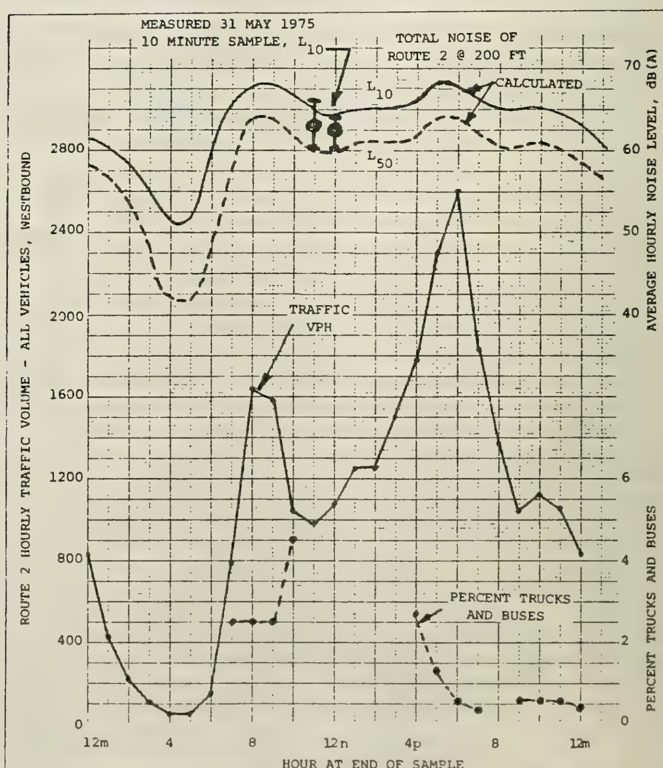
Location	Date	Time	Noise Level	Predominant Source
Rindge Towers Apt. at grade	May 1975 weekday	7:30AM	L_{10}=66 to 70	Alewife Brook Parkway
Rindge Towers Apt at grade	May 1975 weekday	10 PM	L_{10}=62 to 66	Alewife Brook Parkway
Rindge Towers Apt. Roof (thirty stories)	May 1975 weekday	10:30AM	L_{10}=64 to 68	Alewife Brook Parkway
Russell Field 600 ft ± to Alewife Brook Pkway and Rindge Ave	March 1975 weekday	4:00PM	L_{10}=61, L_{90}=55	Various
Field North of Rt 2 - distance:	May 1975 weekday			
165'	"	11:00AM	L_{10}=62 to 66	Rt. 2
185'	"	12:30PM	L_{10}=60 to 64	"
220'	"	12:00PM (noon)	L_{10}=60 to 64	"
240'	"	12:00PM	L_{10}=56 to 60	"

400 VPH including both directions) even a few trucks could influence the L_{10} noise values significantly. The hourly noise value is plotted along with the traffic data (Westbound only) and the hourly truck and bus counts (on a different week day in May 1975) are shown in Fig. 7.B. Relevant measured data from the Alewife Traffic Improvement Study obtained in fields north of Route 2 by BBN are also indicated in Fig. 7.B.

STATION NOISE CRITERIA

For underground stations such as Alewife the noise of trains is literally bottled up by the structure. Minor leaks may occur at emergency tunnel exits and ventilation shafts and at entries when the doors are open. Station ventilation ductwork may conceivably transmit train noises along with fan noise to outdoor louvers. None of these paths represent a major source of train noise, however, for any receptor at more than about 50 ft from such apertures.

FIG. 7.B: ROUTE 2 TRAFFIC AND ASSOCIATED NOISE



APTA criteria for community noise depend on the community land use catagories although these catagories are also characterized by APTA with representative L_{50} (time average) noise levels. These two APTA criteria are reproduced in Tables 7.D and 7.E. Thus, these criteria permit individual train passages to exceed the average night time ambient noise level by as much as 45 dB(A) for the case of a commercial Guilding in a quiet low density suburban area (Category I) to as little as 10 dB(A) for a residential structure in a commerical area (Category IV). The train noise level is to be measured at 50 ft. or more from the track centerline, preferably at the critical receptor locaction.

TABLE 7.D: General Categories of Communities Along Transit System Corridors

Area Category	Area Description	Typical (Average or $^*L_{50}$) Ambient Noise Level
I	Low density urban residential, open space park, suburban.	40-50 dBA - day 35-45 dBA - night
II	Average urban residential, quiet apartment and hotels, open space, suburban residential, or occupied outdoor area near busy streets.	45-55 dBA - day 40-50 dBA - night
III	High density urban residential, average semi-residential/ commercial areas, parks, museum and non-commercial public building areas.	50-60 dBA - day 45-55 dBA - night
IV	Commercial areas with office buildings, retail stores, etc., primarily daytime occupancy. Central business district.	60-70 dBA
V	Industrial areas or freeway and highway corridors.	Over 60 dBA

$^*L_{50}$ is the median noise level.

TABLE 7.E: Criteria for Maximum Airborne Noise from Train Operations

Community Area Category		Single Event Maximum Noise Level Criteria		
		Single Family Dwellings	Multi-Family Dwellings	Commercial Buildings
I	Low Density Residential	70 dBA	75 dBA	80 dBA
II	Average Residential	75	75	80
III	High Density Residential	75	80	85
IV	Commercial	80	80	85
V	Industrial/Highway	80	85	85

For reasons not obvious from the APTA text, "quiet" outdoor recreation areas have a criterion of 65 dB(A) for the maximum noise of individual trains regardless of ambient noise or surrounding land use category. Presumably this "quiet" designation of a recreation area is discretionary. This issue is probably not relevant to the Alewife station unless the "linear park concept" mentioned at several meetings with the station architects is implemented and deemed to fall into this category. The adjacent highways should then be subject to comparable noise criteria even though that approach seems unrealistic at this time.

COMMUNITY VIBRATION CRITERIA

The APTA guidelines for groundborne noise from rapid transit facilities as perceived inside nearby buildings are expressed in a similar fashion to outdoor airborne noise except that the limits are, with two exceptions, 40 dB lower for the various building types and land use categories, see Table 7.F. Train passage noise is of no concern if the tracks are over 200 ft (60m) away from residential buildings and motels. Underlying this statement by APTA are the assumptions that there are no unusual geological features which might enhance vibration transmission, that the tracks and wheels are smooth, and that there are no crossovers, switches or other special trackwork in the adjacent tunnel that could increase the source level of the vibrations. Special consideration should be given to vibration sensitive land use regardless of the category appropriate to the surrounding area, e.g. theaters, laboratories with vibration sensitive equipment, and recording studios.

These APTA criteria are resonable except possibly for the use of the A-weighted noise level. The frequency range where most of the ground borne sound occurs is lower than the passband of the A-weighted filter and it is not at all certain that the relationship between A-weighted noise level and the low frequency rumbling noise level typical of a

TABLE 7.F: Criteria for Maximum Ground-Borne Noise from Train Operations

		Maximum Single Event Ground-borne Noise Level		
Community Area Category		Single Family Dwellings	Multi-Family Dwellings	Hotel/Motel Buildings
I	Low Density Residential	30 dBA	35 dBA	40 dBA
II	Average Residential	35	40	45
III	High Density Residential	35	40	45
IV	Commercial	40	45	50
V	Industrial/Highway	40	45	55

train passage is independent of the type of building, its interior finishes or its furnishings. In some buildings the A-weighted level may be negligible in comparison to the background noise while the low frequency rumble is quite obvious and the vibrations may themselves be felt. Vibrations per se are not discussed by APTA (see 7. Construction Noise and Vibrations) however, the threshold criteria appropriate to construction vibrations could be applied to train induced vibrations. In general vibrations are not severe and only the associated audible noises need to be handled.

The APTA guidelines suggest that the ground borne train passage noise be made unobtrusive but not necessarily undetectable. This criterion is therefore subject to the usual vagaries of human reaction to intrusions. A compromise between cost and noise intrusion must be considered in physically close situations. Outright purchase of a building may prove a feasible alternative in some cases.

The tools for eliminating the anticipated ground transmitted noise in buildings adjacent to rapid transit tunnels are only partially developed at this stage. Even with detailed geometric and geological data, and accurate transit system characteristics, such noise estimates will probably be accurate to only $\pm$ 10 dB. For this reason, if the cost is acceptable, rail or tie vibration isolation techniques should be considered if the adjacent land uses include noise sensitive areas such as sleeping spaces and if they are <u>less than 500 ft. from the station</u>. If total costs for such treatments are unacceptable, additional engineering studies should be undertaken to estimate the noise and its impact on the particular land use more accurately in hopes of reducing or eliminating the vibration isolation treatment. Consideration should be given to future nearby developments, e.g. the W. R. Grace plans.

Temporary Conditions

GENERAL

The APTA standards do not discuss temporary noise and vibration produced by the construction of rapid transit facilities. The Red Line Extension EAR discusses the potential impact of construction noise extensively, although, principally for the Harvard Square area.

AIRBORNE CONSTRUCTION NOISE

Federal regulations on construction equipment noise by the EPA are beginning to appear. The new EPA regulation limits the noise from newly manufactured portable air compressors to an average sound level of 76 dB(A) when measured at a distance of 7 meters (approximately 23 feet). This is an average reduction of 12 dB(A) from the noise levels of existing units.

The regulation will be effective January 1, 1978, for new compressors with rated capabilities of 75 to 250 cubic feet per minute, inclusive, and effective July 1, 1978 for new units with rated capabilities above 250 cubuc feet per minute.

Noise emission standards for new medium and heavy duty trucks, whic contribute significantly to construction noise, will be established by EPA in 1976.

Federal enforcement of this regulation will be at the place of manufacture and consist of product verification testing, compliance labeling, selective enforcement auditing procedures, and warranty and antitampering requirements. In-use enforcement is the responsibility of State and local jurisdictions.

The General Services Administration has issued construction noise limits to be part of a building's specifications. They also include a reduced noise output goal for January 1975. We are not aware of how successful the implementation and monitoring of such a specification is. It is clear however that even the 1975 noise level goals are quite optimistic and probably unachievable for existing equipment without extensive noise control treatment.

Equipment to be employed on this site shall not produce a noise level exceeding the following limits in dBA at a distance of 50 feet from the equipment under test.

Equipment	Effective Dates 7/1/72	1/1/75
Earthmoving		
front loader	79	75
backhoes	85	75
dozers	80	75
tractors	80	75
scrapers	88	80
graders	85	75
truck	91	75
paver	89	80
Materials Handling		
concrete mixer	85	75
concrete pump	82	75
crane	83	75
derrick	88	75
Stationary		
pumps	76	75
generators	78	75
compressors	81	75
Impact		
pile drivers	101	95
jack hammers	88	75
rock drills	98	80
pneumatic tools	86	80
Other		
saws	78	75
vibrator	76	75

Availability of really quiet equipment is not expected through these and other regulations during the anticipated station construction period. Strict control of the permitted time for construction activities appears to be the only practical feasible means of limiting the community exposure to noise and vibrations. The Alewife station site is fortunately well separated from existing residential areas, e.g. 700 ft. or more from Rindge Towers and Rindge Avenue, 400 ft. or more from Russell Field, and 1000 ft. or more from East Arlington and Whittemore Avenue residences. At the closest of these distances even an extremely noisy machine, for example, an untreated large bulldozer producing bursts of 90 dB(A) at 50 ft. will be virtually indistinguishable at about 1000 ft. from the measured daytime ambient transient noise level (L_{10}) of 62 dB(A) typical of this area.

Stationary equipment that is used at night, for example, tunnel shaft ventilation fans, should be specified not to exceed the night time residual (L_{90}) noise level in the residential areas, typically 40 to 50 dB(A) depending on the hour and distance from the major traffic arteries.

CONSTRUCTION VIBRATIONS

At distances of 500 ft. or more even a large pile driver (e.g. 35,000 ft./lb., diesel driven) would cause no perceptible vibrations in average soil. An interesting comment on dealing with public reaction to intensive construction vibration (and noise) has been published (Wiss, 1974):

"An important facet, that too frequently is learned the hard way, is to require and establish good public relations with the neighbors. One of the most effective techniques is the pre-construction survey. This consists of advising the property owners (or their agents) of the planned construction, and systematically inspecting and documenting the existing condition of the structures. This serves several beneficial purposes: (1) It advises them of the project and lets them know what to expect; (2) it lets them know that you are interested in them and want to be sure that there are no existing structural conditions in their building that require special considerations in the new construction procedures; and (3) it documents, to both of your advantages, what is the existing condition of the buildings, i.e., what cracks exist in the building prior to the new construction. If changes occur during construction the sooner they are detected, the better it is for both parties to know, so that corrective measures can be taken to minimize the damage. It is suggested that self-discipline is better than imposed regulations."

APPENDIX E

Definition of Terms

APPENDIX E

Definition of Terms

The following definitions are implied for terms used throughout this report:

1. Air Relief Shaft. A vertical shaft at each end of a station connecting it to the surface. The primary function of the shaft is to intercept the current or blast of air created by piston action and divert it away from the station platform.

2. Alignment. The graphical and/or mathematical description of the route of the proposed facility in the horizontal plane.

3. At Grade. The rapid transit utilizes existing ground or existing grade. Some regrading and/or addition of ballast may be necessary. See Figure II-1.

4. CBD. Central Business District.

5. Construction Easement (Temporary Easement). Temporary utilization of private property during construction. After construction operations, the property is restored to its original condition; the owner retains possession of his land; and the MBTA relinquishes its rights.

6. CRR. Commuter Railroad.

7. Construction Methods. Refer to deep bore tunneling and cut-and-cover construction. Details of both methods are defined in Definition 36.

8. Construction Shaft. A structural enclosure extending from the surface to the level of the bottom of the deep bore tunnel. The shaft is the starting point for tunneling and serves as the point where people and material move in and out of the tunnel.

9. Cut-off Wall. A ground-support wall which will not allow seepage of groundwater and soil movement. Water can be removed from the excavation without affecting the groundwater level outside the walls.

10. Decking (Temporary). A timber or metal cover placed on temporary beams supported at the side walls of an excavation by either temporary walls or the permanent structure. This operation is performed as soon as practicable to normalize traffic, and the deck and supporting structure are completely removed when tunnel construction is completed.

11. <u>Depressed</u>. An underground section open to the surface. (See Figure II-1). Generally, three types of depressed sections were considered for this project:

    a. <u>Open Cut</u> - a trapezoidal section in soil.

    b. <u>Retaining Walls</u> - retaining walls on both sides. A light deck can be added.

    c. <u>Boat Section</u> - walls on both sides with an enclosed bottom. Used in areas where a high water table prevails. A light deck can be added.

12. <u>Dewater</u>. The process of removing groundwater from the construction area. This may be accomplished by pumping out the water as it enters or by lowering the water level so that it is below the construction area.

13. <u>Distortion Tolerances</u>. In deep bore tunnels, the allowed dimensional variations which occur as a result of distortion of the tunnel structure due to external loads.

14. <u>Fan Shaft</u>. A ventilation shaft provided with mechanical fans which serve to draw in fresh air or exhaust contaminated air.

15. <u>Geometrics</u>. The mathematical description of the vertical and horizontal alignments which make up the route of the proposed facility. Top of rail and centerline of track are the references used for descriptions.

16. <u>Grade Separation</u>. Elimination of an at-grade crossing of a street or highway and a rapid transit or commuter railroad line by a bridge or overpass.

17. <u>Grating</u>. Covering for surface openings which allows air to pass through and has the capability of supporting pedestrian and highway loads. It generally consists of a mesh of steel bars at right angles and is utilized to cover ventilation openings in streets or sidewalks.

18. <u>Intermodal</u>. Referring to either an activity or a facility where a transfer occurs from one form of transportation to another, (e.g. between train and bus).

19. <u>Lay Up Track</u>. An additional length of track generally connected and adjacent to the inbound and outbound tracks. The purpose is to provide temporary storage for trains without interference to normal rapid transit service.

20. <u>Light Deck</u>. A type of roof provided for depressed sections with retaining walls or depressed boat sections. It is designed to support only light loading such as for linear park development.

21. <u>LRV</u>. Light Rail Vehicle. A streetcar or rail passenger vehicle that is smaller and lighter than the conventional rapid transit car. It is powered by electricity, usually from overhead wires or catenaries, and is capable of operating as a signal unit or in tandem with other cars. The existing Green Line cars are light rail vehicles.

22. <u>Mezzanine</u>. The intermediate level of a subway station which lies between ground level and the station platform, and generally, overlooks the platform. This level is usually used for fare collection.

23. <u>Modal Split</u>. Percentage of total person trips made by each mode of transport.

24. <u>Permanent Easement</u>. The permanent use of private property for a specific purpose. A permanent easement would be required regardless of the type of construction method utilized. See Definition 7. The owner retains possession of his land, and the MBTA is given permanent control of its facility and the right to determine what can be constructed above it.

25. <u>Permeability</u>. The ability of a soil to conduct or discharge water under a hydraulic gradient.

26. Piston Action. The phenomenon whereby air is pushed forward by the action of a fast moving train in the relatively constricted space of a subway tunnel. The result is a strong current of air at the end of the tunnel.

27. Profile. The graphical and/or mathematical description of the route of the proposed facility in the vertical plane. Sometimes referred to as the vertical alignment.

28. RDC. Rail Diesel Car. Self-propelled commuter railroad car of the type presently used on the MBTA Commuter Rail system.

29. Recharge. Replacing groundwater to the level that existed prior to dewatering.

30. Slurry Wall. An underground wall constructed by digging or drilling a trench which is prevented from caving in or collapsing by the addition of a watery mixture of bentonite (sodium-montmorillonite). The wall is then constructed directly in the trench.

31. Soil Grouting. Chemical and cement grouting of soils are used to stabilize and consolidate the soil and to control water.

32. Station Post. Signs posted at regular intervals along the route of the subway which indicate the distance from a fixed zero reference point.

33. Tangent Section. The portions of the subway alignment which lie in a straight line.

34. Team Track. Railroad siding and loading dock facility that provides freight service to local customers by transporting freight from the siding to the customer by truck.

35. TOPICS. Traffic Operations Program to Increase Capacity and Safety. A Federal Aid program established by the Federal Highway Act of 1968 with the dual purpose of relieving traffic congestion and improving highway safety in cities. It features low-cost operational improvements readily attainable through the use of traffic engineering techniques.

36. Tunnel. An enclosed underground section. See Figure II-1.

a. Deep Bore. An underground section achieved by boring beneath the earth's surface to permit construction of a facility. This construction may take place in either rock or soft ground. Access to the work is usually from a construction shaft.

b. Cut-and-Cover Construction (Conventional Method) Conventional cut-and-cover construction procedures would be used for all sections except where special conditions require slurry wall construction.

Along the limits of the section, soldier or "H" piles are placed in augered holes to a depth which safely retains the earth and protects foundations of adjacent structures. As each pile is placed, the hole is filled with standard strength concrete to the level of the subway invert, and the balance is filled with lean concrete or gravel. See Figure II-3

If the construction site is along a street, vehicular traffic is temporarily diverted. Excavation proceeds to a depth of six to eight feet and during this phase, utilities are either suspended from transverse beams spanning the excavation or relocated outside its limits.

After timber decking is placed on the transverse beams, traffic can be restored. As excavating continues under the deck, lagging is fastened to the soldier piles while struts and bracing are placed to carry horizontal loads.

When the excavation reaches the invert elevation, forms are set and concrete poured.

After the subway structure is completed and the top waterproofed, backfill is placed, utilities restored, and the roadway reconstructed.

For this project, to determine where special conditions might dictate modified construction, further subsurface investigations will be required before final design.

c. Cut-and-Cover Construction (Milan Method)

This method applies slurry-trench construction techniques to cut-and-cover tunneling. The steps in the method are described below and shown in Figure II-4.

(1) Excavate a trench along the tunnel alignment for the construction of guide walls. These walls are commonly about five feet deep and serve as guides for the slurry-trench excavating equipment. This construction is done in-the-dry.

(2) Excavate the slurry-trench to the full depth of the tunnel wall, using bentonite slurry for support. Place the reinforcement and the concrete.

(3) Installing lateral bracing as needed, excavate between the walls to an elevation corresponding to the underside of the roof. Cut keys into the walls for roof supports. Place a leveling-slab of lean concrete (mud sill) on the bottom of the excavation if a smooth roof underside is desired.

Backfill is then placed on the roof and the utilities and traffic restored. For large spans, a center row of columns may have to be constructed before the backfill is made.

(4) Continue excavation under the roof and between the tunnel walls.

(5) Construct the invert and complete the tunnel structure.

37. <u>Tunnel Invert</u>. Elevation of bottom of tunnel section.

38. <u>Umbrella Technique</u>. Subsurface construction under busy streets can be accomplished by using temporary bridging. Recently developed, this method minimizes disruption of normal pedestrian and vehicular activity during the construction period.

Initially, an intersection is completely covered with an "umbrella" comprised of steelwork panels covered with concrete road surfacing. See Figure II-5. The completed "umbrella" spans the intersection approximately 3.5 feet above the existing roadway.

Excavation and construction of a transit station then takes place under the umbrella by means of access shafts located away from the intersection itself. At the completion of the work, permanent roads are replaced under the decking, panels are removed, and the roadway intersection reopened.

As mentioned in the BTPR Red Book, a famous example of this technique is the "Oxford Circus Umbrella" used by the London Transport during the construction of its new Victoria Line. Placement of the umbrella was accomplished over a three-day weekend. During the five years the umbrella was in place, it carried over 44 million vehicles without any interference from construction. When construction was completed, the umbrella was removed over another three-day weekend and the intersection restored to its normal condition.

39. <u>Underpinning</u>. For existing structures, this construction process provides new or revised foundations or supports which will transmit the load of the structure to a soil strata or location which will not be subject to disturbance during tunnel construction.

40. <u>User Benefits</u>. Benefits directly accruing to system users due to improved service quality and transportation opportunities. Includes reduced travel time and cost, improved travel convenience and improved access and mobility.

41. <u>Ventilation Shaft</u>. A vertical shaft connecting underground transit structures with the surface in order to supply fresh air or exhaust contaminated air.

Appendix F

MUNICIPAL CONSIDERATIONS

Appendix F

MUNICIPAL CONSIDERATIONS

An in-depth community liaison program was established to advise the MBTA and the Consultant on the local municipal considerations affecting the station planning and environmental assessment of the proposed Red Line Extension. The organization and content of the liaison program was outlined in Chapter II. This chapter reviews implementation of this program in Cambridge, Somerville and Arlington, and presents the results of these efforts. Local issues and concerns identified during the liaison effort are outlined by community and station areas. Finally, legal constraints, such as policies, plans and zoning ordinances, relevant to the project are reviewed and summarized.

CAMBRIDGE

Community Liaison Programs

Citizen advisory groups and broad base community participation programs were established for the three stations located within the City of Cambridge. These advisory groups served as the principal vehicle for implementing the community liaison program. The liaison program varied significantly owing to the uniqueness of the Harvard Square Station, the local neighborhood orientation of the Porter Square Station, and the broader regional significance of the Alewife Station.

Harvard Square

Based on interviews and review of previous studies, groups and individuals active in the Harvard Square area were identified. Those groups and individuals potentially affected by the project were also identified and were kept informed of the project's status through the study. Letters were sent to public officials informing them of the study's progress. In addition, a news release announcing the beginning of the study appeared in the Cambridge Chronicle on July 4, 1974.

The first workshops were conducted with community groups, businessmen, governmental agencies, Harvard University and others. These meetings were held to explain the study process, and to solicit comments on previous studies and on general areas of concern from members of the community. These first meetings set up the channels of communication between the MBTA, the Consultant and the community which were utilized throughout the study.

Contact with the community continued during the evaluation of alternatives. Meetings were arranged when certain aspects of an alternative appeared to have a significant effect on a particular segment of the community.

A second series of workshops and informational meetings was conducted after a set of station and alignment alternatives was developed. These sessions were arranged with groups and individuals previously consulted as well as with others who had not participated in the first meetings. At each meeting the participants were asked to respond to the alternatives proposed. If questions were raised which could not be satisfactorily answered at that time, another meeting was scheduled. Comments were recorded in memoranda prepared after each meeting.

Although the small workshops proved to be an excellent method of promoting community participation, citizens who did not belong to a formally organized community group were often excluded from this process. Therefore, several large-scale public forums were conducted. The Cambridge Transportation Forum sponsored an evening meeting at which the Consultant gave a presentation on the project and solicited comments from the audience. Also, a three-hour walk-in session was held at the Brattle Theatre on a weekday afternoon. This session was set up to encourage participation by those unable to attend evening meetings. The Brattle Theatre session included the showing of films which examined the building of London's Victoria Line subway. The films were also shown at a meeting one evening at the Cambridge Adult Education Center. All public forums and film showings were publicized in newspapers and on a local radio station. Area businessmen were notified of the Brattle Theatre session by letter.

An informational brochure summarizing the proposed alternatives and associated impacts was published. The brochure was not meant to be a detailed examination of the alternatives but, in conjunction with the public meetings, it provided a basis for members of

of the community to formulate opinions on the alternative lines. The brochure was distributed to those groups and individuals who participated in the meetings as well as to the community at large. Each brochure contained a form which could be torn out and returned with comments.

A final public meeting sponsored by the Harvard Square Development Task Force was held two weeks after the informational brochure was distributed. At this meeting a full presentation was made covering all alternatives studied. The various groups were asked to submit their positions on the alternatives. The comments were assembled and given to the City and the MBTA for review prior to reaching an agreement on a preferred alignment.

Porter Square

The Porter Square Transportation Advisory Group (TAG) was formed by the City of Cambridge in January 1975. An extensive mailing was undertaken to encourage participation by representatives of neighborhood, business and civic organizations as well as interested City departments, commissions and individual City Council members. Five TAG meetings were held, beginning on January 30, 1975. Each meeting was advertised in the news media and was open to the public. Discussions focused on clarifying issues involved in the location and design of the Red Line Extension from Harvard Square to Porter Square including the proposed Porter Square Station. Numerous informal meetings were initiated to further increase the productiveness of each formal meeting. No key decisions affecting the proposed station were made without consultation with the principal TAG representatives.

Following review, examination, and discussion of alternative station locations, the TAG reached a consensus that Station B.4 (revised) was the best scheme for Porter Square. When it was concluded that the taking of private property would be unavoidable, property owners and potentially displaced business persons were personally invited to attend the TAG meetings to discuss the project with other affected or interested persons and to consider options available for relocation. An MBTA relocation specialist held a special briefing at the third TAG meeting, March 20, 1975, to outline available relocation assistance.

A land use subcommittee was formed as a part of the Porter Square TAG to provide continuity between the station location, planning and environmental assessment activities and the detailed land use studies to be undertaken following project approval. At an organizational meeting held on April 29, 1975, a small steering committee was established to direct future land use study efforts, thereby affording continuous citizen input to that phase.

The Cambridge City Council endorsed the Porter Square TAG selection of the station B.4 (revised) in a resolution passed June 23, 1975.

Alewife Brook Parkway

The Alewife Task Force was established jointly by the City of Cambridge, Metropolitan Area Planning Council, MBTA and Metropolitan Department of Public Works. The group was comprised of representatives from more than 40 different interest groups. This group met either weekly or biweekly beginning in March 1975 to formulate a general community policy statement on an alignment and on the station and garage location. Additionally, the Alewife Task Force discussed other issues and topics related to station development such as future land use, preservation of open space, and highway improvements. In organizing the Alewife Task Force, an attempt was made to encourage maximum participation by all State, regional and local agencies, groups, or organizations--both public and private--with an interest in the Alewife station. Consequently, many of its members were representatives of such State and local agencies as the Central Transportation Planning Staff, Metropolitan Area Planning Council, Metropolitan District Commission, and the Planning and Engineering Departments of Belmont, Cambridge and Arlington. The business community and local conservation and environmental groups were also well represented.

Two subcommittees were established to deal with land use and the concept of an Alewife linear park. These subcommittees met aside from the regular Task Force meetings to develop policies for submission to the entire Alewife Task Force for review and endorsement. Two specific subcommittee products were: 1) two general development plans for future land use in Alewife; and 2) a conceptual open space or linear park plan for Alewife. Several proposals and recommendations, made by these subcommittees and endorsed by the Alewife Task Force, are included in this report.

Other Informational Activities

Other informational and advisory activities included the representation of city officials on the Red Line Working Committee, an ongoing participatory group which is advising the MBTA and the Consultant on total project or corridor issues. Frequent presentations have been made to Cambridge organizations such as the Chamber of Commerce Transportation Committee. A model of the proposed Porter Square Station was prepared and used in a presentation by the Consultant at a May 10, 1975 Community Street Fair sponsored by the North Avenue Congregational Church in Porter Square.

A project library for the Red Line Extension was established at the Central Library, 440 Broadway. It contains all relevant studies and reports to provide interested citizens with background information and data on the project. Citizens were invited to submit comments or questions concerning the project on pre-addressed and stamped cards available at the project library.

Issues

Many issues and concerns were identified based on the review of existing city policy statements, media coverage of previous Red Line Extension proposals, transcripts of relevant public hearings, interviews and community meetings. These issues generally fell into two categories--those which apply to the City as a whole and those which are relevant for individual station areas. The major citywide issue concerning all station areas is the desire for the Red Line Extension to continue to Route 128. Those issues relevant to a particular station area are discussed below.

Harvard Square

- Study alternatives A-(I), D, G and no-build.
- Previous alternatives C, E, F and H be dropped from further consideration.
- Compatibility with the Harvard Square Comprehensive Policy Plan.
- Levels of structural and property displacement.
- Potential building settlements or noise-vibration effects.

- Review of bus service. Need for improved longer-haul, crosstown bus service in which bus routes do not terminate at Harvard Square. Opportunity for reducing bus volumes in the Harvard Square area.

- Prepare and make available plans, or a simple model, that would permit City officials and the general public to understand the present system of tunnels, ramps, stairs and platforms that make up the existing Harvard Square station.

- Station entrances and exits should be located to maximize use by people within reasonable walking distance of the station, weighted according to potential users, as follows:

  Employees in the Harvard Square area - highest priority.

  Travel to work by residents of Harvard Square - second priority.

  Customers of Harvard Square businesses - third priority.

- Cost effectiveness of all alternatives.

- Minimize adverse effects of construction and maintain traffic and pedestrian circulation as near normal as possible.

- Rapid transit and bus service during construction must remain as close as possible to the present level of service.

- Effect of proposed station designs on pedestrian, vehicular and bicycle activity.

- Provision of access from Brattle Square to the station.
- Proximity to the Harvard University complex.
- Potential impact on historic sites and buildings of national and local significance in the area.
- Construction methods.
- Capital and operating costs.

Porter Square

- Amount of property takings required.
- Possible location of a station at Davis Square.
- City Council's support of a station at location B (BTPR Red Book) in its resolution of April 30, 1973.
- Proximity of station to shops and businesses north and south of the MBTA Commuter Rail Line tracks.
- Possible limitation of Somerville alternatives by selecting an alignment out of Porter Square which favors one alternative over the other.
- Ease of transfer between the commuter rail station and the proposed Porter Square Station.
- Location of station entrances to permit improved pedestrian access.
- Provisions for security in station design to aid in discouraging crime.
- Provision of access from the street and the commuter rail station for handicapped and elderly riders.

- Provision of free pedestrian tunnels under Massachusetts Avenue for non-riders.

- Improvement of the appearance and rider amenities in the vicinity of the commuter rail station.

- Possible changes visible at the surface after completion of the project.

- Not providing for Red Line Extension commuter parking or for off-street bus loading facilities at Porter Square.

- Prohibiting transit users from parking in adjacent residential areas, the Sears, Roebuck and Co. lot, or the Porter Square Shopping Center parking area.

- Potential disruption of traffic on Massachusetts Avenue during construction.

- Use of residential streets for new feeder bus routes.

- Potential new commercial development resulting from the station.

- Compatibility of new development with existing commercial activities in Porter Square.

- Future of the Sears, Roebuck and Co. store in Porter Square.

- Compatibility of the project and induced development with the existing residential environment in the vicinity of the station.

- Effect of the proposed station on property values, rents and taxes.

- Potential type of residential development generated by the station.

Alewife

- Amount of property takings required for the proposed station, garage and alignment.
- Accessibility of station from surrounding neighborhoods and the adjacent area of industrial development.
- Impact of proposed station, garage and alignment on environmentally sensitive areas and 4(f) lands.
- Compatibility of station location with operations on the Freight Cutoff of the MBTA South Acton Commuter Rail Line.
- Visual impact of station and garage on character of surrounding neighborhoods.
- Effect of station and alignment on flood retention capabilities of the area.
- Potential traffic disruption during construction.
- Impact of construction techniques on surrounding neighborhoods.
- Number of transit parking spaces.
- Number and size of access ramps at garage and amount of land required for the ramps.
- Amount of additional traffic generated by the new station and induced development.
- Potential changes in noise and air quality.
- Geometry of proposed highway improvements in the vicinity of the station.
- Potential development generated by the project.
- Impact of induced development on environmentally sensitive and 4(f) lands and parking requirements.

- Effect of project on tax base and local employment.

- Effect of project on detention and detention capacity of floodplain.

- Opportunity for development of a linear park.

- Impact of project on wildlife and vegetation.

Plans

A Comprehensive Policy Plan for the physical development of Cambridge is presently being prepared. In the preliminary draft of the Harvard Square Comprehensive Policy Plan--a portion of the citywide plan--policies were established to serve as guidelines for future development of the Harvard Square area. City resolutions on the Red Line Extension and station locations will be included in any future policy plan for Cambridge.

Policies

A Cooperative Agreement between the City of Cambridge and the MBTA was signed on October 16, 1970. The portions which apply directly to the proposed Red Line Extension are briefly summarized as follows:

- Extension of rapid transit to West Cambridge is in the best interests of the City.

- The MBTA and the City will exchange information and emphasize enhancement of the community in future studies.

- Neither party will execute a contract for final design for any transit or development project until preliminary plans, general locations and alignments have been carefully reviewed by the other party.

- Both parties agree to actively promote and encourage implementation of mutually acceptable transit or transit-related development project.

On October 26, 1970, the Cambridge City Council unanimously adopted a resolution petitioning the MBTA, the Governor, and the Legislature to again give highest priority to the Red Line Extension.

Following the BTPR study, on April 30, 1973, the City Council unanimously passed a second Red Line resolution. This resolution was based on a study by the Departments of Community Development and Traffic and Parking which recommended supporting the extension because it would:

- Provide more jobs and tax revenue.
- Reduce the need for expressway construction.
- Reduce the need for commuter parking.
- Increase employment opportunities for Cambridge residents.
- Reduce commuter traffic on City streets.
- Reduce the number of buses on City streets.
- Reduce the City's annual payment to MBTA.

The Council adopted as official policy the following recommendations:

- Extension of the Red Line to Route 128 via Davis Square.
- Provision of a station south of Porter Square only if detailed studies indicate that parking and traffic problems can be resolved.
- Construction of a station at Alewife west of the Parkway and north of Rindge Avenue Extension.
- Utilization of deep-bore construction from the Harvard Square Station to Alewife unless detailed studies indicate that cut-and-cover construction under the Boston and Maine right-of-way from Davis Square to Alewife is acceptable to residents and business interests in North Cambridge.

- Design of the new Alewife area road system--which will serve the Alewife station--to maintain existing retail, office and residential areas and to encourage motorists approaching Boston and Cambridge from towns west of the Parkway to transfer to the Red Line.

- Avoid opening the station at Alewife until the station at Route 128 is opened.

City of Cambridge policy objectives for the Harvard Square Station area as they relate to the design of the proposed Red Line Extension include the following recommendations:

1. Enhance the role of the pedestrian with special attention given to pedestrian access to and within the station; safety and comfort; access for disabled persons; in-station customer services; and security measures. It was also recommended that a review of people-movers be undertaken to determine their feasibility at the Harvard Square Station.

2. Reinforce Brattle Square as the heart of the commercial core, with emphasis on analysis of the economic impact of the station location and entrances as well as changes in shopping patterns and characteristics.

3. Improve the environment. An analysis should be undertaken of the project's effect on air and water quality and noise levels as well as on the existing commercial, residential and institutional environment.

4. Explore opportunities for joint venture between the City and the MBTA such as the potential for new building development on air rights above MBTA property.

On April 8, 1975, the Cambridge City Council adopted a resolution supporting the proposed "D" line/station alternative developed in coordination with the Harvard Square Task Force. Another resolution passed on June 23, 1973, which supported the proposed Porter Square Station, was developed in coordination with the Porter Square TAG.

On March 22, 1976, the Cambridge City Council adopted a resolution supporting the effort to fund and construct the Red Line extension from Harvard Square to Route 128, provided that the first construction phase be at least to Arlington Center and that construction begin at Harvard Square and Arlington Center simultaneously.

Zoning

A zoning ordinance was approved by the Cambridge City Council on February 13, 1961. The ordinance has been frequently amended over the past several years. To implement the ordinance, a zoning map was created which divided the City into 11 districts with land use classifications as follows:

1.	Residence A-1 District	Single-family dwellings
2.	Residence A-2 District	Single-family dwellings
3.	Residence B District	Two-family or semi-detached dwellings
4.	Residence C-1 District	Multi-family dwellings (apartment house, hotel, dormitory)
5.	Residence C-2 District	Multi-family dwellings
6.	Residence C-3 District	Multi-family dwellings
7.	Office District	Business and professional offices and multi-family dwellings
8.	Business B-A District	Local and drive-in retail business
9.	Business B-B District	General business
10.	Industry I-A District	Warehouse, storage and light manufacturing
11.	Industry I-B District	Heavy industry

The boundaries of these districts as they apply to both the Porter Square and Alewife Station areas are illustrated in Figures IV-1 and VI-1.

The Cambridge Department of Community Development is currently studying the citywide zoning and is considering, among other measures, the selective down-zoning of residential areas and citywide height restrictions.

Table F-1 indicates two key zoning ordinance restrictions on land use development by district.

Table F-1

ZONING ORDINANCE RESTRICTIONS--CAMBRIDGE

District	Maximum Ratio of Floor Area to Lot Area	Maximum Height in Feet
Res. A-1	0.5	35
Res. A-2	0.5	35
Res. B	0.5	35
Res. C-1	0.75	35
Res. C-2	1.75	85
Res. C-3	3.0	none
Office	3.0	none
Bus. B-A	1.0	35(bus); 85 (res)
Bus. B-B	4.0	none
Ind. I-A	2.0	none
Ind. I-B	4.0	none

Figure F-1 provides a graphical interpretation of the potential massing or bulk effect of a range of floor area ratios (FAR's) on a single site assuming a height of ten feet per floor and complete site coverage. If the site is not completely covered, the FAR could be rearranged vertically with the resulting forms having a FAR of 4.0.

Descriptions of the relevant land use and zoning along the proposed Red Line Extension alignment and at specific station locations are given in the land use portions of each section analysis.

SOMERVILLE

Community Liaison Programs

The City of Somerville established a citizen advisory group for the Davis Square Station. Formed in January 1975, the Davis Square Transportation Advisory Group (TAG) was organized as an open forum for all interested residents, businessmen and public officials. The Ward Six Civic Association was the primary representative for residents of surrounding neighborhoods. Davis Square

business interests were represented by the Davis Square Businessman's Association, the Somerville Chamber of Commerce and many individual merchants. The City of Somerville was represented by the City Planning Director and several aldermen.

The Davis Square TAG held six meetings, beginning January 29, 1975. Each meeting was advertised in the local news media and was open to the public. Discussions focused on clarifying issues relating to the choice of a station location, station design, and the alignment of the Red Line Extension from Porter Square to Davis Square and the Somerville Cityline. Numerous informal meetings were initiated with neighborhood representatives, businessmen, city departments, commissions and public officials to further increase the productiveness of each formal meeting. No key decisions affecting the proposed station were made without consultation with the TAG.

During the first three TAG meetings, alternative station locations were examined and the membership agreed that B. 2 was the best location for the station. The clear consensus and support illustrated during the selection of the station location was maintained throughout the remaining TAG meetings. When it was concluded the taking of private property would be unavoidable, property owners and potentially displaced businessmen were personally invited to attend a special TAG meeting on April 17, 1975. An MBTA relocation specialist attended the meeting to answer questions and outline available relocation assistance.

A land use subcommittee was formed as a part of the Davis Square TAG to provide continuity between the station location, planning and environmental assessment activities of the TAG and the detailed land use studies to be financed by a $80,000 Federal grant through the Metropolitan Area Council upon approval of the project. This subcommittee is under the direction of the Ward Six Civic Association which is in the process of broadening its membership to include representatives of the Davis Square business community. The subcommittee could serve as the advisory group for the land use study. Its first organizational meeting was held on May 21, 1975.

A land use subcommittee was formed as a part of the Davis Square TAG to provide continuity between the station location, planning and environmental assessment activities of the TAG and the Joint Planning Program to be financed by a Federal Grant to the MBTA and carried out under the general guidance of the Metropolitan Area Council. This subcommittee is under the direction of the Ward Six Civic Association which is in the process of broadening its membership to include representatives of the Davis Square business community. The subcommittee could serve as the advisory group for the Joint Planning study. Its first organizational meeting was held on May 21, 1975.

Other Informational Activities

Other informational activities in Somerville included the representation of city officials on the Red Line Working Committee, an ongoing participatory group which is advising the MBTA and the Consultant on total project or regional issues. Frequent presentations have been made to Somerville organizations such as the Ward Six Civic Association, the Chamber of Commerce and Davis Square Businessman's Association. The Somerville Journal produced several feature articles on key issues being discussed by the Davis Square TAG. These articles helped to increase the public exposure and citizen input.

A project library for the Red Line Extension was established at the West Somerville Branch of the Somerville Public Library, 40 College Avenue. The library contains all relevant studies and reports to provide interested citizens with background information and data on the project. Citizens were invited to submit comments or questions concerning the project on preaddressed and stamped cards available at the project library.

Issues

Many issues and concerns were identified based on the review of city policy statements, media coverage of previous Red Line Extension proposals, transcripts of relevant public hearings, interviews and TAG meetings. These issues are cited below.

- Amount of property takings required.
- Desire for a central station location which would be more convenient for residents and commercial activities.
- Potential traffic volumes and congestion on College and Highland Avenues and on Holland Street.
- Effect of station construction on the local water table level.
- Method of travel construction used beyond Davis Square to Massachusetts Avenue.

- Need to locate entrances on both sides of Davis Square and along Highland Avenue.

- Provisions for personal security at the street level, in the entrance tunnels, and inside the station.

- Provision of easy access to the station for handicapped and elderly riders.

- Future use of lands over tunnels and station after construction.

- Method of removing excavated materials during construction.

- Elimination or depression of the hazardous Freight Cutoff grade crossing in Davis Square.

- Potential congestion resulting from buses entering Davis Square to load and unload passengers.

- Prohibiting transit users from utilizing on- and off-street parking in residential areas.

- Potential disruption of traffic on Elm Street, Highland Avenue, College Avenue and Holland Street.

- Not permitting traffic to be detoured on local residential streets during construction.

- Possible elimination of bus routes on some local streets after the station opens.

- Discouraging kiss-and-ride traffic movements on local residential streets.

- Implementation of TOPICS improvements in Davis Square.

- Potential type of commercial revitalization resulting from the project.

- Effectiveness of existing zoning for regulating the size of potential development.

- Effect of the project on existing job opportunities in Somerville.

- Prohibiting transit users from parking in commercial parking facilities.

- Compatibility of the project and the potential induced development with the existing residential environment in the vicinity of the station.

- Effect of the proposed station on property values, rents and taxes.

- Possibility of significant population changes as a result of the project.

- Impact of operational noise and vibration on residential areas.

- Effectiveness of changes in Davis Square zoning on the control of high-rise, high-density residential and commercial development.

Plans

The Comprehensive Plan of Development for Somerville, passed by the City Council and approved by the Mayor in 1969, has generally guided physical development in the City. Extension of the Red Line into Somerville via Davis Square is consistent with the guidelines and recommendations in that plan. Implementation of many specific recommendations and goals in the plan would be facilitated by the project including:

- Encouraging improvement of existing business areas.

- Providing a focus for commercial activity at Davis Square to help discourage strip development.

- Making land available for recommended new parks and esthetic areas in Davis Square (with removal of the Freight Cutoff).

- Effecting further consolidation of area fire stations (with removal of the Freight Cutoff).

- Improving traffic flow in Davis Square and surrounding neighborhoods (with elimination of the Freight Cutoff).

Policies

A Cooperative Agreement between the City of Somerville and the MBTA was signed on September 22, 1972. The portions which apply directly to the proposed Red Line Extension are briefly summarized as follows:

- Both parties should undertake a coordinated program of study and action to delineate and more fully accommodate needed transportation improvements.

- Both parties in collaboration with Boston Transportation Planning Review and other interested groups should investigate the feasibility of a Red Line Extension from Harvard Square via Davis Square to the same extent and in the same detail as any alternative alignments under consideration.

- Studies should be conducted to develop recommendations designed to provide better service to the residents of the City within a reasonable period of time. Community groups should be established to review, comment and possibly alter these recommendations prior to implementation.

- Both parties agree to consult each other prior to seeking any State legislative authorization for any transit or transit-related development project within the City.

Somerville Mayor S. Lester Ralph stated his official position on the Red Line Extension in a 1973 press release which is quoted in part below:

"After reviewing the report of the Boston Transportation Planning Review, consulting with staff in the Somerville Planning Department and other offices, and listening to concerns of residents and businessmen in the Davis Square area as well as the city at large, I have taken the following position regarding the extension of the Red Line rapid transit from Harvard Square.

"I wholeheartedly support extension of the Red Line to Alewife and beyond and I am strongly in favor of an intermediate station in Davis Square. It is time that the citizens of Somerville, who pay the third highest portion of the M. B. T. A. deficit, receive some first-class service.

"A station in Davis Square would be a major asset to the city of Somerville by providing:

- improved access to jobs and other activities in Boston, Cambridge, the South Shore, and possibly Arlington and Route 128.

- cheaper fares for many Somerville residents (25¢ instead of 45¢) and shortened bus trips for many others.

- faster service, cutting travel times to Boston and Cambridge by as much as one-half.

- a 'shot-in-the-arm' to the Davis Square business community by stemming the loss of stores, jobs, and tax base which has been occurring in that area over the past several years.

- an opportunity to reorganize the bus system and get better service for less money.

- modern, efficient rapid transit an alternative to the energy consuming automobile - at a time when we are faced with an energy crisis and there is serious talk of gas rationing and higher prices for gasoline.

"As part of my position supporting a station in Davis Square, I feel strongly about the following:

1. Deep bore tunneling be used along the entire underground subway route in Somerville except under the Freight Cutoff of the MBTA South Acton Commuter Rail Line.

2. The Red Line subway should be extended beyond the Alewife area if that is in concurrence with the desires of the towns of Arlington and Lexington.

3. If a subway stop comes to Davis Square, a neighborhood based planning task force should be established to consist of:

   a. local residents
   b. resident community groups
   c. local businessmen and business groups
   d. local elected officials
   e. staff from the Somerville Planning Dept. and other related agencies and associations.

4. That the issue of depressing the MBTA Commuter Rail tracks running through Davis Square is a separate issue from the construction of a subway stop."

Zoning

The Building Zone Ordinance of the City of Somerville was passed by the Board of Aldermen February 25, 1960 and approved by the Mayor March 1, 1960.

To implement the ordinance, the City was divided into districts with the following land use classifications:

1.	Residence RA District	Single, two-family, semi-detached dwellings
2.	Residence RB District	Multi-family dwellings
3.	Residence RC Districts	Multi-family dwellings
4.	Business BA Districts	Business uses (allows RA, RB, and RC residential uses)
5.	Business BB Districts	Business uses (allows RA, RB, and RC residential uses)

6.	Industrial IA Districts	Warehousing, storage and light manufacturing
7.	Industrial IB Districts	Heavy industry

The boundaries of these districts as they apply to the Davis Square Station area are illustrated in Figure VIII-1.

An amendment to the zoning ordinance approved by the Mayor on October 1, 1974, provides for a Height Limited Overlay District (HL). This classification can be overlaid on any other district. However, it does not modify allowable land uses in a particular zone except that a height limitation of four stories, but not more than 50 feet above grade, is imposed. Currently, there is only one HL district located in the Davis Square area.

Table F-2 indicates three key zoning ordinance restrictions on land use development by district:

Table F-2

ZONING ORDINANCE RESTRICTIONS--SOMERVILLE

District	Maximum Ratio of Floor Area to Lot Area	Maximum Height in Stories
Residence RA	0.75	2-1/2*
Residence RB	1.0	3*
Residence RC	2.0	none*
Residence BA	2.0	none*
Residence BB	2.0	none*
Industrial IA	2.0	none*
Industrial IB	2.0	none*

*-If within an HL overlay district, maximum height is four stories, but not more than 50 feet above grade.

Detailed descriptions of land use and zoning along the proposed alignment and at the Davis Square Station are given in the land use portions of each section's analysis.

ARLINGTON

Community Liaison Programs

Citizen advisory groups were established for the two stations located within the Town of Arlington. The Arlington Center and Arlington Heights TAG's consisted of citizens appointed by the Town of Arlington Board of Selectmen. Most TAG members were owners of businesses in Arlington Center and Arlington Heights, reflecting the concern for alternatives which would be favorable to maintenance of healthy commercial activity in the Town. Meetings were usually held during the afternoon, however several meetings were held during evening hours for the benefit of those unable to attend daytime meetings.

Each TAG also had a representative of the Selectmen's Advisory Committee on Transportation, a group which was formed in early 1972 and which has continued to play a part in the development of the Town's official policies on the Red Line Extension, as well as representatives from the League of Women Voters. The chairman of the Arlington Conservation Commission was a member of the Arlington Heights TAG and several members of the Arlington Conservation Association (a private organization) were a part of the Arlington Center TAG. Monthly TAG meetings, under the sponsorship of the Arlington Department of Planning and Community Development, provided a public forum for review of station and alignment proposals.

TAG meetings consisted of reviewing plans, receiving comments, analyzing potential impacts and investigating potential mitigating measures. At each session, citizen questions and comments were recorded. Responses and plan modifications were presented at a subsequent meeting.

Efforts were made to identify and contact interested individuals, groups, agencies and Town departments which might be affected by the project. These included the Superintendent of Parks and Recreation, the Director of Community Safety, the Acting Town Engineer, the Department of Public Works, members of the Arlington Historical and Conservation Commissions, the Arlington Public

Schools, the Director of the Arlington Housing Authority, the Arlington Council on the Aging and the Arlington Redevelopment Board. A working session with the Redevelopment Board in conjunction with a special meeting with the Board of Selectmen helped to clarify the crucial issues and needs of the community.

Other Informational Activities

A special open meeting was held to provide an opportunity for citizens to comment on the project as it affected Arlington. Citizens who could not attend afternoon TAG meetings were able to review the preliminary proposals for station location and alignment configuration. Issues raised at this public meeting reflected a different perspective from the largely business-oriented membership of the TAGs.

The Consultant's staff was available for presentations and briefings at the request of affected individuals and citizens' groups. Citizen groups contacted included the East Arlington Residents Association, the Arlington Conservation Association, the Arlington Chamber of Commerce, the League of Women Voters, the Arlington Historical Society and the Mystic River Watershed Association. Those individuals whose properties abut the right-of-way were able to discuss the project during the impact analysis and preparation of preliminary plans. A special effort was made to contact railroad freight users to assess the potential impacts resulting from the discontinuation of direct rail freight service.

A project library for the Red Line Extension was established at the Robbins Public Library in Arlington Center. It contains relevant studies and reports from the Arlington Department of Planning and Community Development, and the MBTA as well as summaries of technical reports and memos describing various elements of the environmental impact assessment. Citizens may submit comments and questions concerning the project on pre-addressed and stamped cards available at the project library.

Citizens were also made aware of the possible extension of the Red Line during 1974 as a result of several informational meetings conducted for the preparation of the Arlington Center Mill Brook Valley Plan. There was intensive discussion during these meetings regarding the Red Line right of way configuration, station designs, and use of transit development as a catalyst for the redevelopment of Arlington Center.

Issues

The most concise statement by the Town of Arlington regarding the Red Line Extension appeared in a Status Report to the Board of Selectmen from the Selectmen's Advisory Committee on Transportation on February 27, 1975. The report stated that the Extension is "generally viewed in a favorable light" since it would provide better transit service for Arlington residents, create the potential for revitalization and expansion of Arlington's commercial areas, and provide the opportunity for improving the environment. However, the report cited five major concerns in terms of possible impacts on the Town if the project is not properly planned and designed or if proper land use controls are not implemented. These are:

1. Potential traffic and parking impacts resulting from location of the Red Line terminus at Alewife.

2. Location and magnitude of parking facilities required by the project.

3. Possibility that the project will attract higher density residential development which may have a negative impact on the character of the Town.

4. Potential noise, safety and visual impacts of the project on established residential and potential residential redevelopment areas near the line.

5. Possible effect of the project on the Mill Brook natural environment.

Other issues important to Arlington include:

- Development of the Red Line Extension as a completely grade separated facility and improvement of unsafe railroad grade separations to reduce accidents.

- Potential impact of vibration, noise, soil settlement and safety on homes which abut the proposed right-of-way and subsequent effect of transit on these property values.

- Development of the Red Line Extension in a manner not to preclude a continuation of current de facto use of the railroad right-of-way as open space.

- Revitalization of Arlington Center with the Red Line Extension as a catalyst for new development. Without the transit extension major revitalization is not likely to occur.

- Possibility of vandalism, especially where the right-of-way abuts parks and playgrounds.

- Possibility that a lower fare to downtown Boston from Arlington Center than from Arlington Heights would create traffic problems in Arlington Center.

The issue of MBTA assessments was raised at a number of meetings with citizen groups. It was explained that modifications of the assessment formula subsequent to the BTPR Study would preclude the kind of localized tax impacts experience in Quincy when transit stations were opened there in September 1971.

The Town's Arlington Center-Mill Brook Valley Plan (published September, 1975) contains many recommendations which are directly related to the Red Line Extension. This Plan was initiated to guide a comprehensive zoning revision (also completed in 1975) in a manner which will coordinate land uses with the transit extension. Implementation is presented in two stages, "pre-Red Line" or 1975 through early construction of the transit, and "post-Red Line" or the period from transit construction to 1990. The Plan refocuses commercial development from the linear pattern prescribed by the old zoning, to three major nodes. It calls for the most intense development to occur at Arlington Center, with two lesser nodes at Arlington Heights and at the Lake Street area in East Arlington. The Plan reiterates the Selectmen's policy that the Red Line be built underground. Construction of a linear park over the transit right-of-way is seen as a method to provide a pedestrian link through the town while minimizing impacts on the residential areas abutting the transit. The MBTA Commuter Rail Line right-of-wa happens to be strategically located for linking the town's activity centers, such as the commercial centers, the high school and major parks. It also serves as a central spine convenient to higher density residential areas. The Plan views as a long-term goal the recreational development of Mill Brook with acquired property and easements along its banks and removal of existing culverted sections.

Availability of transit is expected to generate a substantial amount of new development over the next 15 years. Based on a study by Gladstone Associates, approximately 250,000 square feet of new retail space, 280,000 square feet of office space, and approximately 1,500 additional housing units--principally apartments and multi-family units--are estimated to be constructed by 1990 with improved transit. This anticipated new construction would be even more likely to occur with new

zoning provisions which create further incentives for such development. Anticipated development in advance of or without the Red Line Extension would probably total only 75,000 square feet of retail space, 50,000 square feet of office space and 1,000 housing units. There would also be some rehabilitation and consolidation of retail space. The current housing trend towards multi-family units is expected to continue. The Gladstone study indicated that substantially more than the 1,500 new units expected with transit development could be developed in 10 to 15 years if enough land were available; however, there is little vacant land in Arlington.

The Arlington Center-Mill Brook Valley Plan emphasizes, with or without the Red Line, the need to concentrate retail development in several nodes along Massachusetts Avenue to provide increased opportunity for comparison shopping. The primary node would be Arlington Center with subnodes at Lake Street, Arlington Heights. Subnodes are characterized as community shopping areas. The plan envisions Arlington Heights development to be locally oriented retail and office space for professionals and small businesses. A more detailed discussion of future development can be found in Chapters X and XI.

Future industrial development is expected to be minimal. Major firms which currently rely on freight service, and which could not receive shipment by other means of transportation would probably close down. A new nine acre auto oriented commercial center is planned at Theodore Schwamb Mill. Businesses at the existing Mill site would be relocated.

The plan suggests transportation and traffic improvements to include reinstitution of local bus service to Belmont and Winchester through Arlington Center and scattering of new public parking facilities in Arlington Center between the northwest, northeast and southeast quadrants to minimize impacts on streets. No major alterations in the street network are proposed. A minor change which is proposed is the construction of a new street connecting Winslow Street and Mill Street in the post-Red Line phase. Intersection improvements, construction of median islands and one-way movements are suggested.

A major set of issues emerged after the public hearing on the capital grant application was held at the Town Hall on March 23, 1976. These were raised by representatives of St. Agnes' Parish which has a complex of facilities immediately abutting the proposed location of a parking garage for the Arlington Center Station. The Parish facilities include the Church and Rectory, Arlington Catholic High School, St.

Agnes School and Fidelity House.

The Parish representatives stated that the station Task Force named by the Selectmen was not fully representative, that the planning process conducted for the Red Line in Arlington was inadequate in that it did not recognize the impacts of the parking and terminals proposals on the Parish facilities, and that the proposed parking structure on Russell Common and a temporary transit terminal at Arlington Center were unacceptable.

As a result, the Arlington Selectmen have revised their position on the Red Line and have agreed to establish a more broadly representative station task force. The MBTA is engaging an architect for pre-grant design work whose responsibility will be to develop revised plans for the station complex in close consultation with the Selectmen's reconstituted task force.

Policies

On May 3, 1973, the Arlington Board of Selectmen released a "Public Policy Statement regarding the Red Line Extension in the Northwest Corridor". The Board unanimously supported the Red Line Extension from Harvard Square to Route 128 via the MBTA Commuter Rail Line right-or-way in Arlington, but emphasized that "if the Red Line cannot be implemented in a single package project, the Board does not support any extension of the Red Line beyond Harvard Square in Cambridge". The statement reflected the need for a balanced transportation in Arlington and other Northwest Corridor communities. The Board believed that a terminus at Alewife would not solve the public transportation problem and that it would not meet needs of reverse commuters traveling to the expanding job market in the Route 128 area.

The Board's policy on the Red Line Extension through the Town was that "the alignment must be underground through the entire town thereby eliminating all grade crossings and potential air and noise pollution". A second critical point was the Board's support of the official Cambridge position at the time--that the Alewife Station should not become operational without the extension to Route 128. This 1973 policy statement was reaffirmed in 1975 with no substantive modifications.

A review of the BTPR Red Book by Metcalf & Eddy, dated January 1974, cited a possible position for the Town of Arlington based on certain constraints including the limited availability of construction

funds, potential congestion and flooding problems at the Alewife terminus, need for encouraging higher density development within the Northwest Corridor, and the possibility that only one station might be built in the Town. Metcalf & Eddy recommended that the Town support: the Red Line Extension to Arlington Center, employing cut-and-cover construction; the redevelopment of Arlington Center by rezoning for high-density development in the vicinity of the proposed station and by improving streets and parking; and the use of catenary electrification beyond Arlington Center.

The report prepared by the Selectmen's Advisory Committee on Transportation in February 1975 substantially reflects the views of the Selectmen. It emphasizes the Town's support for the transit extension and makes recommendations that address the Town's five major concerns which are cited again below:

- Terminating the Red Line at Route 128 to reduce the impact on local streets and development and to provide access to the highway system.

- Minimizing parking requirements while emphasizing other means of access to the transit stations.

- Preserving the character of the Town.

- Avoiding noise, safety, physical and visual impacts of the project on areas adjacent to the proposed alignment by locating the line underground.

- Conserving the natural environment.

In addition to the above concerns, the report stated that the project would provide an opportunity for improving the environment since an extension over the existing commuter rail line would eliminate some of the negative effects of that facility.

In a public policy statement, dated February 9, 1976, the Arlington Board of Selectmen reaffirmed their unanimous support for the Red Line Extension, as a complete transportation project, from Harvard Square in Cambridge through Alewife and then on the MBTA Commuter Rail Line right-of-way to Route 128 in Lexington. The Board's position includes a firm commitment to any funding and construction strategy through Arlington Center as the first phase. Excerpts from the public policy

statement are quoted below.

"The Board realizes the complexities of an undertaking of this magnitude and, therefore, recognizes the necessity of adopting a program of phased implementation whereby each succeeding phase is under construction prior to the opening of the preceding phase. We accept this concept. The Board has taken this position for the following reasons:

1. The Governor has repeatedly emphasized the need for a balanced transportation system. There is no question that an extension and upgrading of the Red Line from Harvard Square to Route 128 will assist in accomplishing this end.

2. The Town of Arlington and other municipalities in the Northwest Corridor are in dire need of efficient public transportation. No longer can we be almost totally dependent on the automobile. This is particularly true in light of the increasing energy crisis.

3. Terminating the line at Alewife Brook is not a panacea for alleviating automobile congestion in the inner suburbs and the core city. Local and regional commuter needs as they now exist and as they will develop in the future, must be met by providing good access to all points of destination throughout the entire Northwest Corridor. Extending the Red Line from Harvard Square to Route 128 will be a major step in meeting these needs. Equally important is the opportunity for reverse commuting from the inner city to Route 128 with an ever expanding potential job market in the entire Route 128 area".

The Board expressed concern that the Minuteman Area Transportation Improvement Study is incomplete at this time and stated that "any decision on an Arlington Heights Station must await the results of the study."

On May 5, 1976 the Board revised its earlier position to state that they would not support a terminus, permanent or temporary at Arlington Center and would not support any above ground parking garage or bus terminal at Russell Common.

In October 1976, the Arlington Board of Selectmen, in an official policy statement, moved "...that the official position of the Board of Selectmen is that we oppose the extension of the Red Line until those responsible for mass transportation produce the necessary plans and funding to accomplish our goals, namely, that of an underground configuration, throughout the Town; that there will be no terminus in Arlington, temporary or permanent, and that it will ultimately extend to Route 128; further that although we will cooperate in any way to assist in developing the information, citizen input and plans to accomplish these and related goals and objectives, we rescind our support until the total package has been produced acceptable to the citizenry of this community. Said action is not to be construed as lack of support for the concept of mass transportation through the development of the Red Line."

On April 13, 1977, a resolution was adopted at the Annual Town Meeting which stated that the Town will not support a proposal of the MBTA to construct an extension of the Red Line in Arlington until such time that prior to such construction it shall develop a satisfactory proposal which conforms to the wishes of the People of Arlington; that the extension be completely of an underground and covered configuration; that it be completely through the Town of Arlington with no temporary or permanent terminus; and that construction be done in one single phase.

Zoning

The existing zoning ordinance for the Town of Arlington was originally passed in 1924. It is defined as a "telescopic" ordinance in that it is structured to permit less intensive uses in zones indicated for higher intensity uses. The original ordinance consisted of strip zoning based on the distance from the major arterial, Massachusetts Avenue. The linear development of the Town's commercial activities was a result of this ordinance. Business A and B zones were generally defined as being within 125 feet of Massachusetts Avenue. A Residence C-1 zone was established from between 125 and 300 feet of Massachusetts Avenue; it runs easterly from Park Avenue to the eastern boundary of Arlington on the south side of Massachusetts Avenue and from Broadway to the eastern boundary on the north side. Apartments can be constructed on a minimum lot size of 20,000 square feet in this zone; a 35 percent coverage and a maximum height of 75 feet are permitted. However, this intense level of development has not been reached due to the current abundance of small parcels within the zone and also because residents do not know about existing permitted uses.

Table F-3

ARLINGTON ZONING ADOPTED OCTOBER 1975

DISTRICTS		MAXIMUM F.A.R.
Residential	1 - Single family	0.35
	2 - Two family	0.35
	3 - Three family	0.75
	4 - Town house	0.70
	5 - Apartment--Low density	0.80
	6 - Apartment--Medium density	1.20*
	7 - Apartment--High density	1.50*
Business	1 - Neighborhood offices	0.75
	2 - Neighborhood business	1.00
	3 - Village business	1.40
	4 - Vehicular-Oriented business	1.20*
	5 - Central business	1.80*
Industrial		1.50
Planned Unit Development		4.00
Hospital		1.00
Transportation		0.35 or for extension by air rights into T-District, the controls of the district from which extension was made apply.

NOTE: *Bonus provisions permit increased F.A.R. in these districts to 1.5, 2.0, 1.5 and 2.4 by special permit.

A new Zoning Bylaw was passed by the Town Meeting in October 1975. The Town is awaiting approval of the Bylaw by the Attorney General. The new Bylaw reflects existing uses as well as the development goals outlined in the Arlington Center-Mill Brook Valley Plan. It calls for the most intensive development in and around Arlington Center and in the Planned Unit Development district. The next most intensive commercial districts are at Arlington Heights and at Lake Street. On Massachusetts Avenue, between these nodes, a commercial development is limited to a series of districts, separated by residential districts, which permit only smaller scale "neighborhood businesses" or auto-oriented businesses. The new bylaw includes floor area ratio bonuses for open space, large lots, easements for public access, historic preservation, large dwelling units, and inclusion of low-or-moderate-income residential units. Table F-3 lists the new districts.

In Arlington Center, new zoning districts were carefully drawn to accommodate Arlington Center-Mill Brook Valley Plan recommendations. Certain sites which will be involved in the Red Line Station/Garage development were carefully rezoned to discourage redevelopment in the pre-Red Line period. These sites will be "upzoned" according to the Plan recommendations when the transit facilities are designed and their construction is imminent.

The B & M right-of-way was included in the "Transportation" District. This district is designed primarily for transportation and open space uses. Uses in adjacent districts can extend into the T district with air rights development. The Plan recommends that development in the southeast quadrant of Arlington Center be so extended.

Zoning for Arlington Heights (B3) largely conforms to the existing intensity of development. This zoning reflects the strong recommendation which evolved through extensive public participation in the Arlington Center-Mill Brook Valley planning process. People are strongly opposed to more intensive development and more traffic in the Heights. Thus, except for the Station site and MBTA parking lot, zoning in the Heights will remain the same in the post as in the pre-MBTA period.

APPENDIX G

SECTION 106 CASE STUDY AND MEMORANDUM OF AGREEMENT

SECTION 106 CASE STUDY AND MEMORANDUM OF AGREEMENT

DETERMINATION OF EFFECT ON NATIONAL REGISTER PROPERTIES

1. Old Harvard Yard

2. Cambridge Common Historic District

PURPOSE OF THE PROJECT

The Massachusetts Bay Transportation Authority (MBTA) proposes to file an application for Federal capital grant assistance to construct 6.34 miles of two-track, fixed-rail rapid transit from the Red Line's present terminus in Harvard Square, Cambridge to a point in Arlington Heights, Arlington. New stations would be built at Harvard Square, Porter Square and Alewife Brook in Cambridge; Davis Square in Somerville; Arlington and Arlington Heights in Arlington. The major portion of the undertaking would be constructed in tunnel/deep bore or cut-and-cover.

THE REASON FOR SECTION 106 REVIEW

The proposed undertaking would be within and near two overlapping historic districts in the Harvard Square area. These districts, designated "Old Harvard Yard" and the "Cambridge Common Historic District" are listed in the National Register of Historic Places as it appeared in the Federal Register, Volume 39, Number 34, Part II, dated February 19, 1974. Several structures within these districts have been designated as National Historic Landmarks by the Secretary of the Interior.

SUMMARY OF PROCEDURAL ACTIONS

In accordance with the procedure for compliance with Section 106 of the National Historic Preservation Act of 1966, the following actions have been undertaken to date:

1. A preliminary consultation took place on November 7, 1974 among representatives of the Massachusetts Historical Commission, UMTA, City of Cambridge Historical Commission, MBTA, and the consulting engineers for MBTA. The purpose of the meeting was to inform the interested parties of various alignments under consideration and define the geographic areas subject to impact by each of the design options.

2. The Cambridge Historical Commission prepared an unofficial listing which identified significant properties within the project's area of influence. These included National Register properties; properties considered eligible for Register nomination; and other properties considered to be of architectural, historic or environmental value to the community.

3. Periodic meetings were held to acquaint representatives of the Cambridge Historical Commission with specifics of the various alignment options as studies developed.

4. The consulting engineers prepared an informational brochure which included, among other data, the identified historic properties affected by each of the alignment options, the probable impacts and the mitigating measures that would be required. The brochure was distributed prior to a public meeting held on March 4, 1975.

5. The Cambridge Historical Commission provided a written analysis of potential impacts on National Register properties and ranked the various alternative alignments according to degree of negative effect. (See Exhibit A--letter from the Cambridge Historical Commission dated March 10, 1975.) The alignment ranked by the Commission as the least impactive was the one selected for "the undertaking" and is supported by concensus of the community.

6. Copies of the Harvard Square chapter of the draft E.I.S. were distributed to the Historical Commissions of Massachusetts and Cambridge on December 5, 1975. Comments were requested.

7. A consultation took place on January 14, 1976 among representatives of the Massachusetts Historical Commission, UMTA, City of Cambridge Historical Commission, MBTA, and the consulting engineers for MBTA. The purpose of the meeting was to review the status of the undertaking, the possible impact on historic resources, and Section 106 procedures as they pertain to the Harvard Square Area. (See EXHIBIT B -- memorandum of the meeting prepared by the consulting Engineers.)

8. Comments on the January 14 consultation were written by the Executive Director of the Massachusetts Historical Commission. (See EXHIBIT C -- letter dated January 16, 1976) and by the Cambridge Historical Commission (EXHIBIT D -- letter dated January 30, 1976).

9. The comments in the letters (EXHIBITS C and D) were addressed in the final draft of the Environmental Impact Statement.

10. An on-site inspection of Harvard Square and consultation was held April 13, 1977, and is reported in Exhibit N. This constituted a consultation with the Advisory Council on Historic Preservation representative, who requested this inspection.

DESCRIPTION OF PROPERTIES

Old Harvard Yard District

The following description is taken from the National Register Nomination Form:

> The district designated as Old Harvard Yard consists of a large, tree-shaded, roughly rectangular open space and smaller peripheral spaces to the west and south. Adjoining on the east are portions of Harvard Yard that developed after the designated district, achieving their present character in the twentieth century. The Old Yard's spaces are defined by freestanding buildings, most of which are

three or four stories high and built of brick. The oldest building, Massachusetts Hall, dates from 1718; the other buildings that help define the principal space were built over the succeeding century and a half. The only twentieth century buildings, all of which are compatibly neo-Georgian in style, are on the periphery of the district, walling it off from surrounding traffic noise.

All the Old Yard's buildings are (or were built as) dormitories or academic buildings except Wadsworth House, a two-story, gambrel-roofed wooden dwelling built in 1726 as an official residence for Harvard presidents and used as such until 1849. Nearly all the Old Yard's buildings have been remodeled on the inside, but their exterior integrity remains intact.

Cambridge Common Historic District

The following description is taken from the National Register Nomination Form:

The Cambridge Common Historic District includes the Cambridge Common, streets bordering the Common including Massachusetts Avenue, Peabody Street, Garden Street, and Waterhouse Street, and the surrounding land and buildings to a depth of about 100 feet back from the streets. The boundary line is deeper on the Peabody Street side to include Harvard buildings in the oldest part of the Yard, and on the Massachusetts Avenue-Garden Street corner to include the Old Burying Ground and Christ Church.

In addition to the Common, the District contains the following important properties: First Church, Unitarian (1833, Isaiah Rogers), a wooden Gothic Revival church, the exterior of which is in original condition except for the absence of finials around the spire; the Old Burying Ground (1635), a wooded lot of uneven terrain containing over 80 17th century stones and the 1734 milestone "8 Miles to Boston;" Christ Church (1760, Peter Harrison), a simple wooden building with arched windows and a Doric frieze, intact with the exception of two bays that were added in 1857 to lengthen the building; 1 Garden Street (1820, William Saunders), a wooden Federal-style house in good condition; Fay House (1806) in the Radcliffe College Yard, a brick Federal-style mansion rebuilt for college purposes in 1890 (Longfellow, Alden & Harlow); First Church, Congregational (1870), Abel C. Martin), a traprock church trimmed in granite and brownstone; 7 Waterhouse Street (c. 1753), originally a three-bay wooden house with later additions of the two right-hand bays and entrance porch; Harvard-Epworth Methodist Church (1891,

A. P. Cutting), a Richardsonian stone church; Gannett House (1838), a Greek Revival house with full four-column portico; and Harvard buildings including Stoughton Hall (1804, Charles Bulfinch, architect, Thomas Dawes, master builder), Harvard Hall (1764, Governor Francis Bernard, designer, Thomas Dawes, master builder), Massachusetts Hall (1718), all brick buildings of early, middle, and late Georgian design.

The Cambridge Common itself represents the remaining portion of the common lands, orginally extending north to Linnaean Street and beyond, set aside for cow pastures and public meetings, with the part nearest Harvard Square used occasionally for military drill. The "Path" from Charlestown to Watertown which crossed the Common from Kirkland to Mason Streets was the first way to the west in the Massachusetts colony and followed an earlier Indian trail.

The Common was diminished in 1724 when the northern portion was subdivided into parcels and the north boundary was moved back from Linnaean Street to Waterhouse Street, a decrease from 86 to about 16 acres. Roadways divided the area, but houses and shops were soon built around the new boundary and a row of elms was planted c. 1700 along Garden Street so that the limits of the Common were defined and the space enclosed. This sense of enclosure was reinforced by Christ Church, a schoolhouse, and other buildings after 1760. A boundary adjustment occurred at this time when a lot of the common lands was purchased by founders of Christ Church to add to their building lot and another strip of land from the common lands was added to the Burying Ground to straighten the boundary. The Proprietors of the common lands conveyed the Common to the city in 1769 for use as a training field, in apparent anticipation of coming hostilities.

During the Revolution, the Common was the headquarters of the Continental Army, with barracks for the soldiers located in the west corner. Afterwards the Common was still an open field of uneven topography with narrow roads crossing the area. After construction of the West Boston Bridge in 1792 and the Craigie Bridge in 1809, the area became a busier intersection of the trade routes linking Boston with the west, Massachusetts Avenue, the Concord Turnpike, and Mason-Brattle Streets.

In the 19th century, the Common began to take on its present appearance. In 1830, under special legislative authority and direction of a commission, a group of citizens was permitted to enclose the main Common by a granite post and wood rail fence as at present, diverting the

roads then crossing it, and to plant trees. An attempt was made by the county the following year to reopen the direct route west, but was denied in a court case so that the Common remained closed to traffic. At this time many of the remaining building sites around the Common were filled, and the sense of enclosure increased.

In the mid-19th century, crosswalks were laid out and trees were planted along the walks and around the edge of the Common, and the path system began to take on its present form. The park assumed a ceremonial air with the addition of Soldier's Monument in 1869, three Revolutionary War cannon in 1875, the scion of the Washington Elm in 1876, the John Bridge Statue in 1882, and several granite markers at historic sites. The Common became a recreational area as well when baseball was introduced in the west corner in the second half of the 19th century. Additional park area was created when a part of Massachusetts Avenue at the north corner was enclosed and landscaped some time after City Council approved plans in 1858. The area, sometimes called the North Little Common, remains a well-protected and well-maintained green space in the district.

The three small areas of the Common changed considerably in the early 20th century. The installation of the subway ramp in 1909-1912 cut up the Little Common between Massachusetts Avenue and Peabody Street (plots 2 and 3 in the 1830 survey) and Flagstaff Park was created in 1913 to improve the surface. The Holmes lot was traded to Harvard in 1929 in exchange for the lot of the present Central Fire Station.

Presently the Common is in need of renovation, particularly new landscaping and improvement of the path system. Such renovations are being proposed with a 1975 completion date. Improvements may change the appearance of the Common, but any alterations will be in keeping with the historic site as required by the Cambridge Historical Commission Ordinance of 1963.

The Cambridge Common has been the focal point of political, religious, and social activity in Cambridge for well over 300 years. Set aside for grazing in 1631, the Common became the location of annual elections for the governor of the colony in 1636, and the site of George Whitefield's controversial sermons in 1740. The Common was the center for rebellious activity in the years preceding the Revolution, and the main camp of George Washington's Continental Army in 1775-76, with barracks in the west corner. In the early 19th century, the Common was significant as the intersection of major trade routes through Cambridge, and

in 1830 as an early example of dedication, enclosure, and improvement as a public park.

Several significant buildings and sites surround the Common. Architecture of major 18th and 19th century styles are represented by a church, a house, and four college buildings of the Georgian period, two important Federal-style houses, a Greek Revival house with elaborate detail, a Gothic Revival church, and two masonry churches of the Queen Anne period. These buildings are historically significant as well: First Church, Unitarian was built for the Unitarian branch of the First Church in Cambridge after the congregation split in 1829 and the new branch abandoned the 1756 meeting house in Harvard Square; the <u>Old Burying Ground</u> which replaced Cambridge's first cemetary contains the graves of Revolutionary soldiers, Harvard presidents, and other early Cambridge citizens; <u>Christ Church</u> (National Historic Landmark), the city's oldest surviving religious structure, was founded by Tories who fled at the outbreak of the Revolution during which troops occupied the building; <u>1 Garden Street</u> was designed and occupied by William Saunders, a master builder responsible for many Federal-style and Greek Revival houses in Cambridge; <u>7 Waterhouse Street</u> was the home of Dr. Benjamin Waterhouse, the scientist who made the use of smallpox vaccine acceptable and popular in the United States; <u>Holden Chapel</u>, the gift of the widow of an English Dissenter, introduced English taste in architecture to Cambridge; <u>Harvard Hall</u> was built by the state to replace the second Harvard Hall which burned when the General Court was meeting there; <u>Massachusetts Hall</u> (declared eligible for the National Historic Landmark status, but not yet accepted), Harvard's oldest existing building, was used along with <u>Hollis Hall</u> as barracks for colonial troops during the Revolution. Adjacent to the Common at the west end of the present Littauer Center is the site of the Hastings-Holmes house which served as the meeting place for the Committee of Public Safety and the headquarters of General Artemus Ward during the Revolutionary period, and was the birthplace and home of Oliver Wendell Holmes, Sr. and Jr., in the 19th century.

The significance of the Cambridge Common Historic District is great: the area contains important landmarks of Cambridge's history; the Common and surrounding buildings represent a 340 year evolution of an area from an open field to an enclosed park in a dense setting; the Historic District itself, established in 1963, demonstrates current efforts by a city to maintain an important historic area.

The boundaries of the National Register Districts described above are indicated on EXHIBIT E.

It is recognized that all significant structures and features within or surrounding a National Register District share equal status with respect to the 106 review process and the impacts on these as a collective entity are reviewed in discussions that will follow. Of the numerous buildings and sites in the National Register Districts and contiguous areas, several will be more sensitive to possible impacts than will others due to close proximity to the project area and these are singled out in the following list. A capsule description and evaluation of importance is included. (Source: "Evaluation of Buildings and Sites Within the Area Surveyed for MBTA Realignment in Harvard Square", August 9, 1974 by the Cambridge Historical Commission) EXHIBIT F indicates the location of these buildings.

1. Harvard Yard

Massachusetts Hall, 1718 (National Historic Landmark)

Primary Importance
Harvard's oldest building
Prototype of 18c. college hall in New England
Essential element of Yard

Wadsworth House, 1726

Primary Importance
Fine early 18c. house, though modified
Residence of Harvard presidents, 1726-1849; only reminder of 18c. directly visible from Mass. Avenue

Holden Chapel, 1742

Primary Importance
Essential element of Yard

Harvard Hall, 19764, enlarged 1842, 1870

Primary Importance
First college building in America entirely devoted to academic (non-dormitory) uses
Excellent Georgian II architecture enchanced by three remodelings
Essential element of Yard

Lehman Hall, 1924: Coolidge, Shepley, Bulfinch, Abbott

Primary Importance
Essential to scale and privacy of Yard; visually dominates and defines space of Harvard Square

Lionel and Mower Halls, 1925: Collidge, Shepley, Bulfinch, Abbott

Primary Importance
Essential elemnts of Yard

Straus Hall, 1925: Coolidge, Shepley, Bulfinch, Abbott

Primary Importance
Essential to scale and privacy of Yard

Memorial fence and all gates, 1899 ff: McKim, Mead and White
(Partly in National Register District)

Primary Importance
Essential to unity and privacy of Yard

2. <u>Harvard Square Area</u>

First Parish Church Unitarian, 1833: Isaiah Rogers

Primary Importance
Fifth meeting house erected by congregation; a Cambridge landmark
Though stripped of ornamentation, still represents Gothic Revival

3. <u>Cambridge Common Area</u>

Cambridge Common, 1631

Primary Importance
Many historical associations

Old Burying Ground, 1635

Primary Importance
Many historical associations

Gannett House, 1838

Moderate Importance
Example of Greek Revival temple house
Poorly related to Common and to other buildings in North Yard

Hastings Hall, 1888: Cabot and Chandler

Important
Good example of Medieval Revival style
Creates spatial definition on one side of Common

Harvard Epworth Methodist Church, 1891: A. P. Cutting

Important
Moderately good example of Richardson Romanesque

A building not rated in the aforementioned evaluation by the CHC is Hemmenway Gym, 1938, which is within the Cambridge Common Historic District and close to the undertaking.

An important feature outside of but contiguous with the Old Harvard Yard National Register District is the existing main entrance to the subway in Harvard Square. The CHC evaluates the structure as follows:

Subway Kiosk, 1928: architect unknown

Very Important
Sound design and massing, excellent scale presently obscured by signs and poles
Essential element of Harvard Square, with important symbolic associations.

DESCRIPTION OF THE UNDERTAKING IN THE HARVARD SQUARE AREA

A. Existing Conditions

At the present time Harvard Square is a terminus point of the subway. The underground station here consists of two-level rapid transit platforms on the east side of the square and two-level busway platforms on the west side. The several platform areas are interconnected by a complex of pedestrian passageways, and a mezzanine directly under the square.

Components of the facility observable at street level include several entrance-exitways to the subway, and an open busway incline in Flagstaff Park where electrically powered busses enter and leave the station's underground bus tunnels. The main point of pedestrian access to the station is at the traffic island in the middle of the Square. Here, stairways to the subway are protected by a low, rectangular kiosk of masonry and glass with a wide overhanging roof delicately framed of metal arched ribs and copper roofing. The island space is shared with an adjacent, active newsstand business housed in a separate structure of undistinguished character.

Another protected stair, small in scale, is located near Lehman Hall and, as an integral element of the Harvard Yard fence, is relatively inconspicuous. A similar stair occurs near Wadsworth House and a small entrance is located on the south sidewalk of Massachusetts Avenue near Holyoke Street, but has been closed for public use.

Four brass placques are located in the pavement of Massachusetts Avenue opposite Wadsworth House. These placques mark the locations

of two 17th century houses, the foundations of which were discovered when the subway was constructed.

The busway incline bisects Flagstaff Park. Substantial, relatively high parapet walls guard the open sides of the two-lane ramp. Park space west of the incline has been paved for public parking but is semi-concealed by a fence and planting. The space on the east is generally verdant with liberal plantings of trees, shrubs and grass which effectively camouflage the busway. A flagpole of monumental character is situated in this section of the park. Above the tunnel portal is a formal paved terrace backed by an ornamental masonry wall. A pedestal-mounted statue of General Sumner occupies the center of the terrace and faces Harvard Square. The locations of the existing surface elements discussed above are shown on EXHIBIT F.

B. Proposed Undertaking

The almost right angle turn of Massachusetts Avenue northward at Harvard Square describes also the path of the proposed undertaking which will follow that right-of-way to the next station stop at Porter Square in Cambridge. From a point in the existing station, approximately in front of Wadsworth House, new tunnels will turn the corner, passing close to Lehman Hall, and immediately emerge into a new two level station extending toward Flagstaff Park. From the new station northward, tunnels will bend toward a straight heading up Massachusetts Avenue and continue in deep (bored) tunnels. Excavations for the tunnels and station in Harvard Square will be dug from the surface. Temporary decking will allow traffic to be maintained while the structural envelope of the tunnels and station is under construction. Thereafter the surface areas would be restored while interior work is carried to completion. Much of the work will involve the removal and rebuilding of portions of the existing station, particularly the area under the present kiosk and, in order to maintain service, it will be necessary that patrons use a temporary station to be constructed on the opposite (south) side of the present tracks and platforms. The extent of surface areas that would be disturbed by construction is shown on EXHIBIT G.

Construction of the undertaking in Harvard Square would require approximately 36 months.

EXHIBIT H indicates a preliminary concept of the new station (below ground). The space under the present kiosk will continue to be the focal point for primary access, fare collection and passenger connections between trains and buses. However the existing maze of stairs and passageways will be replaced with a spacious single-level lobby reached from the surface by a combination of new access elements including escalators, stairs and a passenger elevator as needed to meet functional and legal requirements of capacity, convenience, safety, and accessibility by the handicapped. The locations of these elements with respect to points of surface penetration in Harvard Square and at other locations in the area of the complex are tentative. Final selection will be coordinated with on-going studies of pedestrian and vehicular circulation by

the City of Cambridge. The objectives of these studies is to create a better pedestrian environment by lessening conflicts and congestion and by an allocation of open space more favorable to pedestrians. In principle, it is proposed to provide a main entrance in the general vicinity of the present kiosk, an auxilliary entrance in or toward Brattle Square, an exit or combined entrance/exit at the north end of the station and one or more peripheral entrances in Harvard Square as may be dictated by the final traffic plan.

IMPACTS AND MITIGATING MEASURES

A. Long-Term Impacts

It is probable that the proposed undertaking can be constructed and used with little, if any, permanent adverse affect on the National Register Districts, and the potential exists that some of the effects will be beneficial.

The following is a discussion of issues having impact implications on a long-term basis. The short-term impacts during construction are discussed in a separate section.

1. Noise and Vibration Impacts

Field investigations and analysis indicate that noise and vibration from train operations will cause unacceptable noise and vibration levels in nearby buildings unless suitable control measures are used.

In a report entitled "Noise and Vibration Environmental Impact of the Proposed MBTA Red Line Extension at Harvard Square", July 1975, by Bolt Beranek and Newman Inc., the following buildings of the Old Harvard Yard and Cambridge Common Historical Districts are listed as areas requiring special noise and vibration controls: "Harvard buildings along Massachusetts Avenue (Lamont Library, Wigglesworth, Wadsworth, Lehman, Strauss, Gannet, Walter Hastings), Epworth Church."

The report further shows that noise and vibration can be brought to an acceptable, non-impactive level by utilizing proven design and construction techniques. The following specific recommendations would be implemented:

a. Welded rail and resilient rail fasteners (with a stiffness of 100,000 lb/in or less) would be used in all parts of the tunnel extension as well as in all parts of the present tunnel and station which may be renovated.

b. Floating slab track beds or resiliently supported double ties would be used for all parts of the proposed tunnel with a possible exception under Flagstaff Park.

c. Sections of tunnels with curves of radius less than 750 ft would be treated with acoustically absorptive material.

2. Alterations of Property Within the Harvard Yard N. R. District

The existing, secondary stairways to/from the subway and located along and behind the fence at Lehman Hall and near Wadsworth House would have to be abandoned. As previously described these were built integrally with the fence and each consists of an opening in a panel of wrought iron pickets behind which a plain, box-like structure encloses the rear, sides and roof of the stairway landing. These are illustrated on <u>EXHIBIT K-2</u>.

The entrance at Lehman Hall would be removed when new tunnels are excavated (see later discussion on temporary removal of fencing) and would not be reconstructed. Instead, the affected fence panel would be rebuilt to match adjacent panels and the stairway area behind would become yard space.

Removal of the stairway near Wadsworth house is not required but it also would serve no future purpose, and a similar course of action is justifiable.

These modifications are not seen as being detrimental. The architecture of the fence and the open space behind would be unified and the original purpose for privacy would be retained.

3. Impact on the Setting

The project will not visibly change the setting of buildings and grounds within the N. R. Districts. However, contiguous street and sidewalk spaces in and around the kiosk area will be subject to modifications and thus certain aspects of the overall setting as it exists today would be affected. Modifications will be reviewed by the State Historic Preservation Officer and the Cambridge Historical Commission.

The objective is to mitigate some of the negative aspects, i.e. congestion, vehicular-pedestrian conflicts, visual clutter, and to reinforce positive qualities--Harvard Square's atmosphere of urban vitality and its identity as the focal point of the area. Construction of the subway extension provides an opportunity to initiate actions directed toward these purposes.

There are many important issues to be resolved before a concept of the streetscape in the Harvard Square Kiosk area can be finalized. It is inevitable that existing conditions would be altered but the extent of change is problematic at the present time. Examples of possible changes that may occur include:

- modifications of traffic movements and trafficways;
- restrictions on curbside parking in selected areas;
- widened sidewalks and reshaped pedestrian spaces coordinated with strategically placed subway entrances;

- o improved paving and landscaping;
- o displacement, relocation, and/or renewal of existing street features such as the newsstand, information booth, kiosk, street lights, signs, poles, signals, public phones and other appurtenances.

The MBTA recognizes that the location of entrances, the design of entranceway components and other elements of the streetscape are a matter of concern to the Cambridge Historical Commission and the Massachusetts Historical Commission and it is the Authority's intention to keep all interested parties informed throughout the design development phases. The MBTA has also agreed to preserve the existing Kiosk and re-use the structure at a prominent location within Harvard Square.

One of the predictable, beneficial impacts would be a significant reduction in the number of diesel busses in Harvard Square. Several routes terminate here and are required by schedules to hold-over in the square before returning. As a result, numerous busses at times are parked end to end along the sidewalk next to Harvard Yard. These routes will be dropped or redirected to other stations along the subway extension and would no longer detract from the setting. Furthermore, another source of noise and air pollution would be eliminated.

B. Short-Term Impacts

The primary impacts of the undertaking on National Register properties are those associated with the construction phase. Some are actual and can be mitigated but not avoided. Others are potential impacts which can be prevented. The actual impacts include:

- o General disruption of the setting due to construction activity.
- o Temporary removal of portions of fencing along Lehman Hall.
- o Temporary removal of surface features in Flagstaff Park (statue, flagpole, etc.).
- o Removal of existing trees, shrubs in excavated areas prior to re-landscaping.

Potential impacts include the possibility of structural damage to certain nearby buildings during excavation.

The following discussion describes the actual and potential impacts and proposed mitigating measures.

1. Impact on the Setting

The impact affecting the National Register Districts as a whole is the effect that a major construction effort would have on the area's setting. It will be evidenced by the necessary excavation operations in

Massachusetts Avenue and Flagstaff Park (most visible and disruptive action) followed by erection of temporary roadway decking which will remain until the basic structural envelope of the subway is completed. It is anticipated that much of the surface can be fully restored well in advance of the estimated 36 months of total construction time. Existing busway tunnels will be available to bring construction materials into and out of the affected area and hence will mitigate much of the surface disruption that might otherwise occur.

Temporary traffic reroutings and parking constraints may inconvenience persons visiting the historic districts by automobile. Public transportation, however, will be maintained at present levels of service.

The Historic Districts will be exposed to construction noise and vibration but presently available quieted construction equipment would be used to reduce the impact.

Dust caused by the construction will be mitigated by the deck covering the work area and by an adequate water supply to control the dust.

2. Impact on Individual Historic Properties

a. Old Harvard Yard District

A number of buildings within the district are close to the proposed undertaking and have appreciable architectural or historic importance: Wadsworth House, Lehman Hall, Straus Hall, Massachusetts Hall, Harvard Hall, Lionel Hall, Holden Chapel and Mower Hall. Of these eight buildings, only Strauss, Lehman and Wadsworth Halls would be subject to possible construction impacts. EXHIBIT J-1 shows the relation of the proposed subway to Lehman and Straus Halls.

The alignment of the proposed tunnel would necessitate excavation from the surface along a line passing close to the aforementioned three buildings and would encroach upon a strip of yard space fronting Lehman Hall. To protect these buildings from settlement stresses, a trench-cut slurry wall is proposed which would retain and stabilize the earth behind the line of excavation. Previous experience with the slurry wall construction technique has shown that damage to adjacent buildings at best is non-existent and at worst is insignificant. The quality of workmanship would be controlled to ensure that little or no damage occurs. Approximately 250 lineal feet of masonry and iron fencing bordering the Lehman Hall site would be temporarily removed. Salvageable components such as dressed stone and ornamental iron would be catalogued and stored for re-use. The fence would be rebuilt to match the present design after primary sub-surface construction is completed. All disturbed landscaping and paving would also be renewed. A portion of the fencing that would be affected is shown on EXHIBIT K-3.

b. Cambridge Common District

None of the many important buildings in the District would be

directly affected. However, station construction in Massachusetts Avenue would occur about 30 feet away from the First Church, Unitarian and, though no adverse affects are anticipated, a monitoring program would be implemented as a precautionary measure. If monitoring data indicated that the Church building was beginning to respond to construction activity, appropriate preventative measures would be initiated to eliminate the cause. EXHIBIT J-2 shows the relation of the subway to the church.

These would be restored in their existing locations unless otherwise directed. The Cambridge and Massachusetts Historical Commissions have indicated that the wall presents a visual intrusion on the historic original Cambridge Common and consideration was given to a concept that would permanently remove the wall and possibly relocate the statue. The Advisory Council has agreed to this concept.

Construction in Flagstaff Park would require the removal of about 27 trees, mainly oaks, maples, and elms of small to medium size. The affected area would be re-landscaped with comparable plantings of trees, shrubs and grasses upon completion of construction. Temporary removals would include the flagpole, statue, paved terrace, and masonry garden walls. These would be restored.

The existing MBTA busway ramp would be re-built at approximately its present location. An existing paved parking area in Flagstaff Park would be retained unless an alternate type of surface restoration is directed by the city.

A small segment of sidewalk and lawn near Gannet House and Hemmenway Gym would be disturbed and subsequently restored. Both these buildings are sufficiently close to the construction as to require precautionary monitoring.

The deep bore tunnel posses about 40 to 50 feet from Hemenway Gym and Gannet House, at depth of about 30 feet. Both these buildings are sufficiently close to the construction as to require precautionary monitoring. This tunnel passes under the northern corner of the Cambridge Common and under the North Little Common. The top of the twin bore is 30 to 50 feet below the surface and no surface disruption should occur as a result of this work.

ALTERNATIVE ALIGNMENTS

Studies to route the existing subway through the Harvard Square area to a northward heading along Massachusetts Avenue involved examination of five possible alignments. The alignments, designated A, G-1, G-2, D-1, and D-2 are shown on EXHIBIT C. Alignment D-2 is the selected alignment of "the undertaking". These alignments were selected for study in response to a number of transit and community considerations. A commonality of all the alternatives is that alignments must pass under the Cambridge Common Historical District to reach a northward heading. There are no alignments consistent with the intent of the undertaking which could by-pass this District. Furthermore the considerable number of nationally and locally important historic properties are widely dispersed throughout the project area. It is virtually impossible for any subterranean routing not to be within a zone of influence of one or more such properties.

None of the alignments studied would, by design, permanently alter a National Register building or its setting. In principle all could pass near or directly under such property with imperceptable affect, provided suitable precautions are taken. However, it is recognized that the design and execution of tunnel work is not infallible and that unforseeable adverse affects are possible. Since none of the alternatives involve intentional or predictable effect on National Register properties the evaluations are based rather on the relative potential for adverse impact. Accordingly the number of affected historic properties, their relative importance, and the extent of required precautionary measures and controls were among the several critical issues which led to discarding all alternatives except the D-2 alignment.

EXHIBIT A indicates the various National Register properties within each alignment's range of influence and comments upon potential impacts. Descriptive data and important issues relative to each alternative alignment is shown in tabular form by EXHIBIT M.

SELECTED ALIGNMENT/CONSTRUCTION ALTERNATIVES

The proposed 250 ft. curve radii at Harvard Square is a substandard transit design. The minimum curve radii normally should not be less than 500 ft. The transit alignment within the National Historic Districts contains curves less than desirable minimum to insure no adverse impact to the adjacent structures within the district and maintain construction activity on public right-of-way.

The selected alignment will be constructed by the cut-and-cover method utilizing the slurry wall technique. This technique, although generally more expensive than conventional methods, will provide the required protection to the adjacent structures and minimize surface disruption. Other techniques were considered but dismissed, including:

Deep Bore Tunnel - Since the proposed tunnel connects to the existing facility, it was not possible to obtain the amount of cover normally required over a bored tunnel. The top of the existing structure is about 2 ft. below ground.

Soldier Pile and Lagging - This cut-and-cover technique, although most economical, does not provide the desired protection of adjacent structures. Other methods, such as underpinning, would probably have to be used to protect the adjacent structures.

Sheet Piling - Another cut-and-cover technique that would not provide the building protection that slurry wall provides. Other methods would have to be used to protect the structures.

Continuous Bored Piles - This technique is comparable to the slurry wall. However, there are a limited number of contractors in this country who have expertise with this technique.

All prudent and feasible alternatives have been explored and all design proposals have been reviewed and approved by local and state historical preservation officers (see Exhibit O). All planning to minimize harm to the historical districts during and after construction has been performed.

MEMORANDUM OF AGREEMENT

The following is a copy of the Memorandum of Agreement dealing with Cambridge Common Historic District and Old Harvard Yard Historic District. All concerned parties have agreed in principle to the Memorandum and the Chairman of the Advisory Council is in the process of signing it.

Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

MEMORANDUM OF AGREEMENT

WHEREAS, the Department of Transportation, Urban Mass Transportation Administration, proposes to construct the Red Line subway extension from Cambridge to Arlington, Massachusetts; and,

WHEREAS, the Department of Transportation, Urban Mass Transportation Administration, in consultation with the Massachusetts State Historic Preservation Officer, has determined that this undertaking as proposed would have an adverse effect upon Cambridge Common Historic District and Old Harvard Yard, properties included in the National Register of Historic Places; and,

WHEREAS, pursuant to Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320) the Department of Transportation, Urban Mass Transportation Administration, has requested the comments of the Advisory Council on Historic Preservation; and,

WHEREAS, pursuant to the Procedures of the Advisory Council on Historic Preservation (36 C.F.R. Part 800), representatives of the Advisory Council on Historic Preservation, the Urban Mass Transportation Administration, and the Massachusetts State Historic Preservation Officer have consulted and reviewed the undertaking to consider feasible and prudent alternatives to avoid or satisfactorily mitigate the adverse effect; and,

WHEREAS, the Cambridge Historical Commission and the Massachusetts Bay Transportation Authority were invited and participated in the consultation process; now,

THEREFORE:

It is mutually agreed that implementation of the undertaking, in accordance with the following stipulations and attached letter of April 19, 1977, from Charles M. Sullivan, Executive Director of the Cambridge Historical Commission, will satisfactorily mitigate any adverse effect on the above-mentioned properties.

Stipulations

1. Johnston Gate, Massachusetts Hall, and Harvard Hall. The subway entrance planned for Harvard Square will be designed so as not to intrude on the visual integrity of these properties.

2. Flagstaff Park.

a. The park will be redesigned as outlined in the attached April 19, 1977 letter of Charles Sullivan, Executive Director of the Cambridge Historical Commission (CHC), to the Massachusetts Bay Transportaion Authority (MBTA).

b. The Massachusetts State Historic Preservation Officer (SHPO) and the CHC will stipulate where the Charles Summer Statue and other park furniture are to be relocated if required by the new park design.

c. UMTA shall insure that prior to its redesign Flagstaff Park is documented according to the standards of the Historic American Buildings Survey and the documentation sent to HABS.

d. Any alteration of the park will be reported within 30 days by the SHPO to the Keeper of the National Register of Historic Places.

3. Harvard Square Kiosk.

a. To avoid damage during construction of the Harvard Yard Station, the Harvard Square Kiosk will be dismantled using all reasonable care to ensure that no damage to the architectural elements is incurred, and stored in a location secure from vandals and adverse climatic conditions. Any elements needing stabilization will be treated prior to storage.

b. UMTA will ensure that documentation of the kiosk, including measured drawings and photographs, is gathered prior to its disassembly and distributed to the SHPO and CHC. This documentation, in conjunction with the kiosk construction drawings dated July 25, 1927, will be used to ensure an accurate reconstruction of the structure.

c. After completion of the Harvard Yard Station, the kiosk shall be reinstalled in a manner acceptable to the SHPO and the CHC. The documentation cited in (b) above, in conjunction with the kiosk construction drawings dated July 25, 1927, will be used to ensure an accurate reconstruction of the structure. The structure shall be used as a subway entrance, newstands, information booth, or combination thereof.

4. UMTA will require MBTA to submit final plans and specifications for the projects described in Stipulations 1, 2, and 3 above to the SHPO and the CHC for their review and comment. If either party notes any objections to the plans as they affect properties included in and eligible for inclusion in the National Register, UMTA will, in consultation with the SHPO and prior to taking any action, obtain the Council's comments in accordance with its Procedures, commencing with Section 800.4(e).

5. UMTA will ensure that the subway is constructed in a manner that reduces noise and vibration to a level that will not impact historic properties. This will be accomplished by using proven design and construction techniques including:

a. Floating slab track beds or resiliently supported double ties in all parts of the proposed tunnel and stations where necessary to prevent damage to properties included in or eligible for inclusion in the National Register.

b. Welded rail and resilient rail fasteners in all parts of the tunnel extension and in those portions of the present tunnel and station that will be renovated.

c. Accoustically absorptive material in all sections of the tunnel and stations that require noise control measures.

d. Low resistance duct silencers in tunnel and station vent shafts.

6. UMTA shall retain an archeologist who possesses the qualifications outlined on page 3 of the attached <u>Guidelines for Making "Adverse Effect" and "No Adverse Effect" Determinations for Archeological Resources in Accordance with 36 C.F.R. Part 800.</u> The archeologist shall conduct a survey of the Alewife area in the proposed Red Line Corridor and apply the attached guidelines to obtain eligibility determinations for any properties that appear to meet the National Register Criteria, and proceed to follow the guidelines for all eligible properties, providing the Council with proper documentation.

Page Four

MEMORANDUM OF AGREEMENT
Cambridge Common Historic District
Urban Mass Transportation Administration

(date) 7/27/77
Deputy Executive Director
Advisory Council on Historic Preservation

Charles F. Bingman (date) 4 Aug 77
Urban Mass Transportation Administration

Patricia L. Weslowski (date) 8/11/77
Acting Massachusetts State Historic Preservation Officer

(date)
Chairman
Advisory Council on Historic Preservation

Concur:

(date) 8/12/77
Massachusetts Bay Transportation Authority

(date) 8·11·77
Cambridge Historical Commission

CITY OF CAMBRIDGE
CAMBRIDGE HISTORICAL COMMISSION
CITY HALL ANNEX, 57 INMAN STREET
CAMBRIDGE, MASSACHUSETTS 02139

(617) 876-6800
Extension 344

April 19, 1977

Charles Steward
Massachusetts Bay Transportation Authority
500 The Arborway
Jamaica Plain, Massachusetts

Dear Mr. Steward:

The extension of the MBTA's Red Line and the related reconstruction of the north bus ramp at Harvard Square provides an important opportunity to redesign Flagstaff Park in a manner more in keeping with its original character as part of the Cambridge Common.

The boundaries of the Cambridge Common have been altered many times in its history, but achieved approximately their present form by 1830 when the Common was enclosed and improved as a park. The three sections of the Common east of Massachusetts Avenue (including present-day Flagstaff Park) had been traversed by various highways since the settlement of the town, but they were never built upon. A view taken from the tower of Memorial Hall in 1875 shows them enclosed with post-and-rail fencing and planted with elm trees. With minor changes, these areas of the Common kept this configuration until the beginning of subway construction in 1909.

The present design of Flagstaff Park is the work of the Boston Elevated Railway, whose plans were reviewed and accepted by the Cambridge Board of Park Commissioners in 1910. The street layout was revised from that shown in the 1875 view, and the park was bisected by the six foot high brick walls of the streetcar ramp. A twelve foot wall was erected across the south end of the park; a section of it forms the portal of the tunnel entrance. This wall is also the backdrop for a small paved plaza and a statue of Charles Sumner on a limestone pedestal. The flagpole, which gave the park its new name, was erected by the Daughters of the American Revolution in 1913.

The designers of the new Flagstaff Park introduced an element of Beaux Arts formalism into the rural atmosphere of Cambridge Common. The designers used the walls to enclose the previously open vistas from the east and south, and in so doing altered the traditional perspectives north from Harvard Square and east from the Common. Richardson's Austin Hall had been sited to terminate the view from Harvard Square, while Memorial Hall and the Harvard buildings around the delta between Kirkland and Cambridge Streets were visually extensions of the Common. These vistas were obliterated by the intrusion of the ramp walls and portal. The statue of Charles Sumner, which was made the centerpiece of the plaza, was moved from the delta at Kirkland and Cambridge Streets, where it had been placed in 1902.

The Cambridge Historical Commission favors the redesign of Flagstaff Park. We feel that the necessary destruction of the ramp and walls provides an opportunity to return this part of the Common to a less formal appearance more in keeping with its original character, restoring as well the traditional sight lines in Harvard Square. The present walls and paving are clumsy attempts to make a virtue of necessity. Safety requires a protective barrier around the ramp, but this can be designed as a low wall and visually unobtrusive fence, a more appropriate setting for the statue of Charles Sumner can be found in a redesigned park.

While the Commission favors redesign rather than restoration of the Park, future plans must be subject to the same Section 106 procedures as other elements in the National Register Districts. We welcome the willingness of the MBTA to consult with the Commission and other Cambridge groups on this question.

Yours,

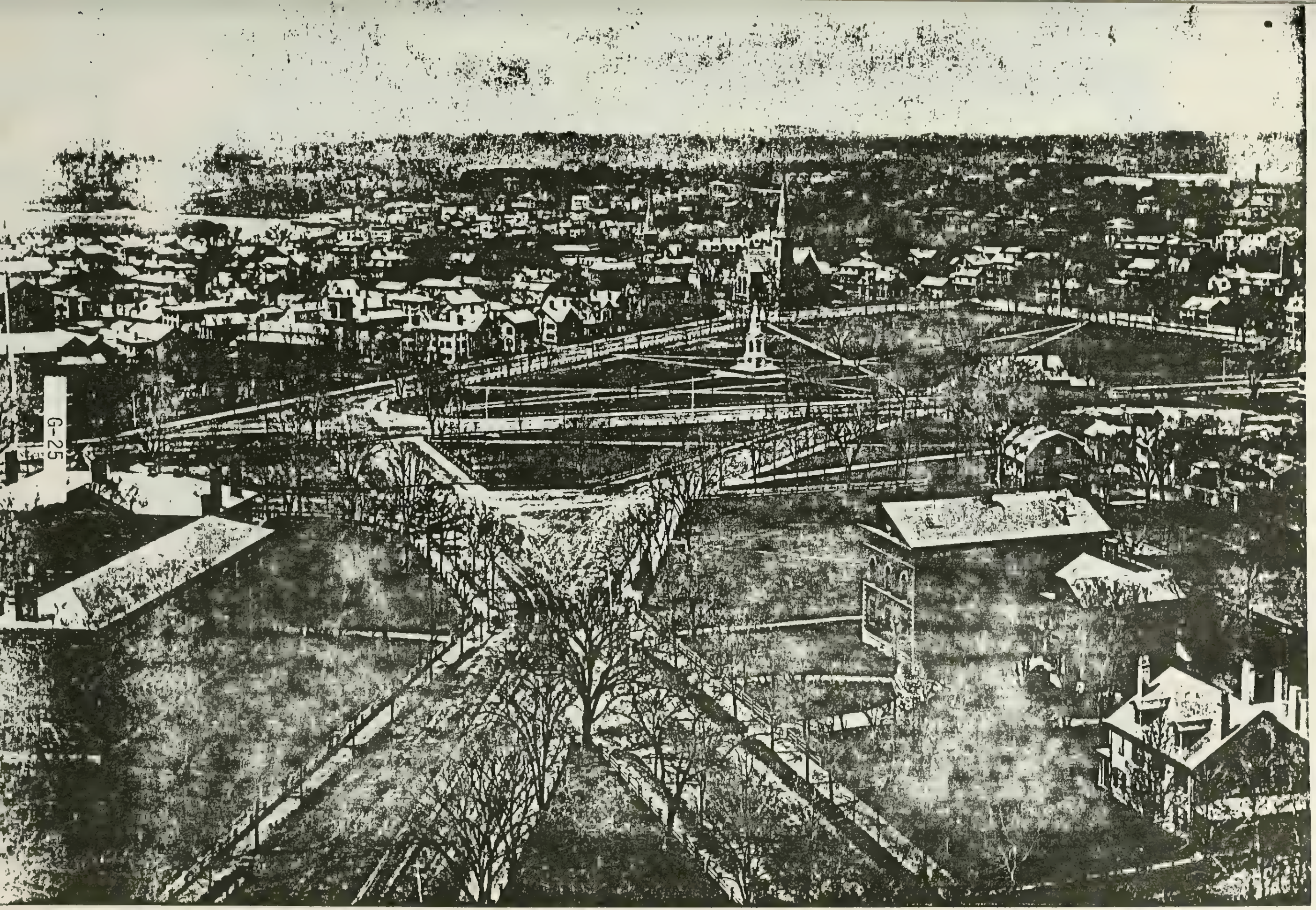
CMSull

Charles M. Sullivan
Executive Director

cc: Sharon Conway, Advisory Council on Historic Preservation
Elizabeth Reed Amadon, Massachusetts Historical Commission
Kiyoshi Mano, Urban Mass Transit Administration

Enclosures

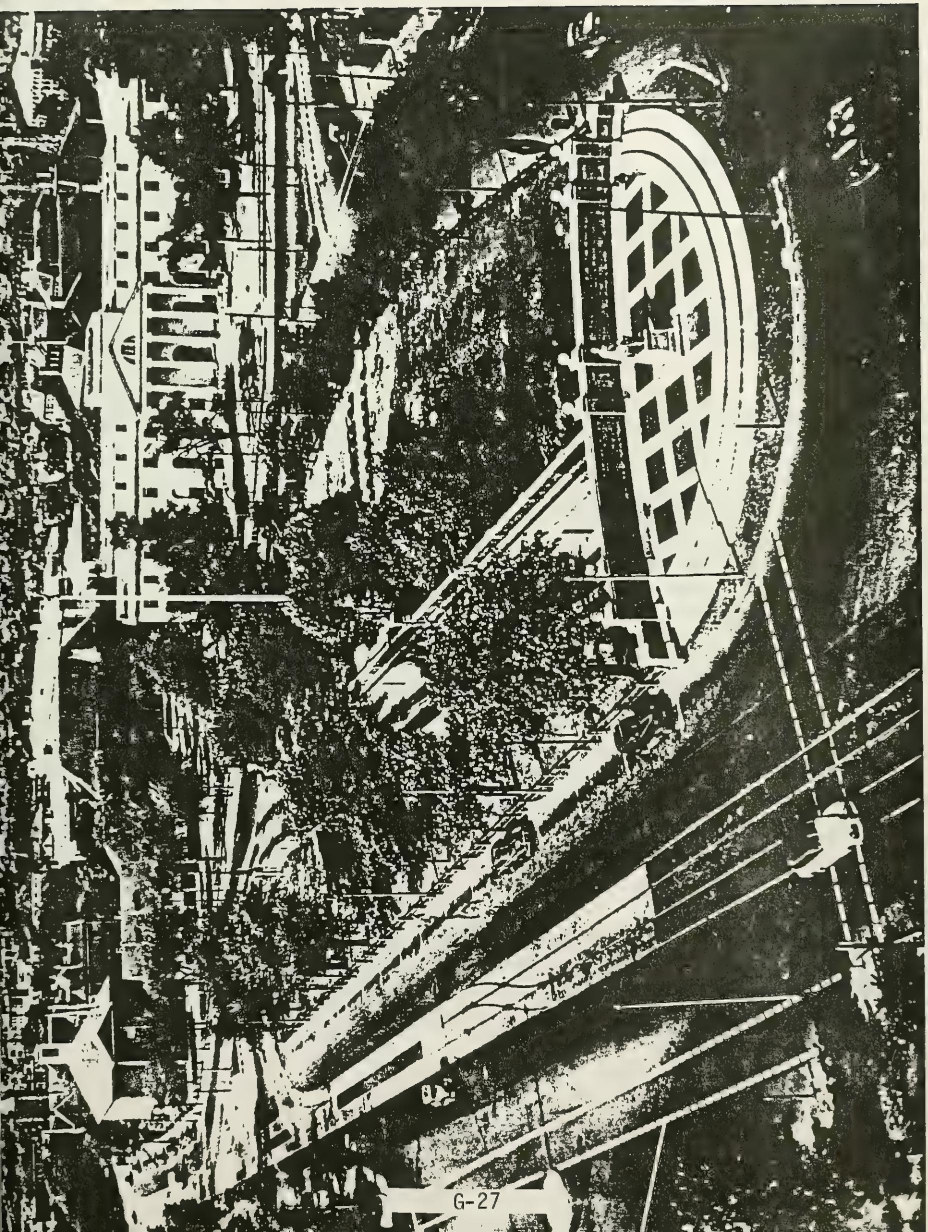

KIRKLAND
DELTA
OXFORD
DIVINITY HALL
AVENUE
PRESBY
Prof. J. Lovering
Prof. Agassiz
Smith
Upham
Dr. E. Howe
Ames
C.C. Foster
Mrs Holmes
Lawrence Scientific School
Cemetery
COMMON
GARDEN
HARVARD
UNIVERSITY
Holden
Hollis Hall
Harvard Hall
University Hall
Gore Hall
Divinity Hall
Stoughton
QUINCY
Brattle House
Unitarian Church
State Arsenal
STREET
MASON
PHILLIPS



View of Cambridge Common from the east, 1875.

Taken from the tower of Memorial Hall.

View of Harvard Yard from the northeast, c1865
taken from point marked in illus. #1



CITY OF CAMBRIDGE

CAMBRIDGE HISTORICAL COMMISSION

CITY HALL ANNEX, 57 INMAN STREET

CAMBRIDGE, MASSACHUSETTS 02139

March 10, 1975

Mr. Dominic E. D'Eramo
Sverdrup & Parcel and Associates, Inc.
648 Beacon Street
Boston, Mass. 02115

Dear Mr. D'Eramo:

This is in answer to your request that the Historical Commission respond to the preliminary designation of five alternative routes for the extension of the Red Line subway.

Given the limited information presently available, the Commission can only rank the alternative according to their possible impact on architecturally and historically significant buildings. The criteria used have been, first, the possibility of direct adverse effect on structures and historic sites as a result of construction and operation, and, second, the indirect effects relating to the probable location of pedestrial entrances. We have also taken into account the relative importance of structures on the National Register of Historic Places, as well as those not on the Register but of local importance. Other factors not related to the effect of extension on structures of historical, architectural, or cultural importance have been disregarded.

Each of the proposed alternative routes has been evaluated in terms of the degree of damage that might be caused to significant structures on or eligible for the National Register of Historic Places. The routes have been ranked in decreasing order according to the potential for damage, as follows:

1. Alignment D-1. This route appears to have the highest potential for damage to structures of historic and architectural significance. The alignment runs along Harvard Yard for the entire length of Peabody Street, passing between Massachusetts and Harvard Halls, Holden Chapel, and

EXHIBIT A

several modern dormitories on one side and the First Church Unitarian-Universalist on the other. The entire Old Yard is on the National Register of Historic Places, and adverse effects on these structures must be minimized. The location of station entrances is not a significant problem in this area.

2. Alignment G-2. This route is also undesirable from the point of view of possible disruption of historic sites and structures. The tunnel passes directly beneath Christ Church, designed in 1760 by Peter Harrison, America's first trained architect, and associated with George Washington's presence in Cambridge during the Revolution; the possibility of damage to this structure must be minimized at all costs. The tunnel also passes beneath a portion of the Old Burying Ground, the only colonial cemetery in Cambridge and the burial place of numerous historical figures. The route along Mount Auburn Street and under Church Street also entails potential adverse effects on numerous structures of local significance, as outlined in our earlier assessment. The location of station entrances does not appear to be a problem.

3. Alignment G-1. This route passes directly by two properties on the National Register of Historic Places, which are also of greatest significance: the William Brattle House and the Dexter Pratt House, 42 and 54 Brattle Street, respectively. The possibility of structural damage from settlement or vibration in this area must be avoided. Furthermore, the placement of station entrances in Brattle Square is likely to result in a sharp increase in property values, making the maintenance of these relatively low-value structures problematical. The route also passes a relatively large number of structures of local significance.

4. Alignment A. This route causes no disruption of National Register structures except those in Radcliffe Yard. However, it does pass beneath an area of small nineteenth century residential structures along Hilliard Street and Hilliard Place, few of which are architecturally or historically important but which constitute a small neighborhood of fine scale and character. Negative effects on this area should be minimized. In other respects, this route causes little disruption.

5. Alignment D-2. This route passes between Massachusetts Hall and the First Church, Unitarian-Universalist, but then bears away from the Yard; disruption beyond this point seems minor.

The Historical Commission is convinced that construction of the Red Line Extension must proceed without delay. Once the final route has been chosen, we will be most willing to work with you and the MBTA to further minimize the negative effects of construction.

If we can be of any further assistance, please feel free to call me or our Executive Director, Charles Sullivan.

Yours,

Robert G. Neiley

Robert G. Neiley
Chairman

RGN/dl

CC: Elizabeth Amadon,
Massachusetts Historical Commission

James L. Sullivan, City Manager

MEMORANDUM

The De Leuw, Cather Organization

To: J. W. Mullaney - Boston
Office: J. L. Angell - Boston
D. D'Eramo - S&P

From: N. J. Pointner II
Office: Chicago

Date: January 19, 1976

Ref. or Job No. 2543-00

Subject: Meeting on Wendesday, January 14 1976 at the Massachusetts Historical Commission

In Attendance:

Elizabeth R. Amadon - Massachusetts Historical Commission
Charles M. Sullivan - Cambridge Historical Commission
George Wey - MBTA
Donald J. Kidston - MBTA
Kiyoshi Mano - DOT/UMTA, Washington, D.C.
Joseph Clougherty - DOT/UMTA, Region I
Jerrell L. Angell - De Leuw, Cather & Company
Norbert J. Pointner II - De Leuw, Cather & Company
D. D'Eramo - Sverdrup & Parcel
A. D. Rudolph - Sverdrup & Parcel

The purpose of the meeting was to review the status of the Red Line Extension Project and the possible impact on historic resources. Particular emphasis was placed upon discussion of Section 106 procedures as they pertain to the Harvard Square area.

Prior to the meeting, Dom D'Eramo of Sverdrup & Parcel had distributed a 12-page draft of information which could serve as a basis for a case report on potentially affected National Register properties in the Harvard Square area. Detailed drawings at 1" = 20' and 1" = 40' were brought to the meeting for this critical area. Aerial photographs at 1" = 400' showing alignment and station locations for the project beyond Harvard Square were also displayed.

The following information was presented concerning historic resources beyond Harvard Square:

A. A bored tunnel would pass in the vicinity of the North Avenue Congregational Church at 1803 Massachusetts Avenue. It is of primary importance on the Cambridge rating system and is expected to be a National Register nominee. It is an 1845 structure by Isaac Melvin of Eyptian-Greek revival character. The structure is located adjacent to the furthestmost extremity of the potential zone of influence from the tunnel which is more than 70 feet beneath the surface. It is not expected that the tunnel will have any influence at all on this structure, but it is mentioned because it is the most significant historic resource along the zone of influence of the transit alignment.

EXHIBIT B

B. There would be some slight, temporary disruption during construction of the Hobbs Building and the Somerville Theater described on page VIII-33 in the review copy of the Draft Environmental Impact Analysis Report.

C. There are no historic resources in the Alewife area and all of the land which will be disturbed through construction of the facility has been previously disrupted by contemporary urban development and dumping activities.

D. In 1967 a .02 acre site, bisected by the B&M Railroad line and surrounded by automobile traffic, was dedicated as Whittemore Historic Park and a statue was erected to commemorate the hero of a Revolutionary War battle which occurred in vicinity. Working through Alan McClennen,Jr., Director of Planning and Community Development for the Town of Arlington, a plan has been devised so that cut-and-cover construction of a transit station in Arlington Center would result in the relocation of the monument and the designated site to a more favorable location, accessible to pedestrians and without the influence encircling traffic. The park is located at the intersection of Massachusetts Avenue and Mystic Streets and would be moved to a location south of Mystic Street and east of Massachusetts Avenue.

E. Railroad abutments at the Brattle Street crossing of the alignment between Arlington Center and Arlington Heights would be displaced by construction of the Red Line along the B&M Railroad right-of-way. These abutments are classified as "of only local interest as examples of fairly common early architectural styles". By following the railroad alignment, virtually all of the more significant examples of historic resources in the corridor have been avoided.

Dom D'Eramo and Allen Rudolph then described in detail the anticipated effects on National Register properties in the Harvard Square area. Although there is no long-term projected impact on National Register properties, short-term impact would occur during construction. Mrs. Amadon agreed that the selected alternative was the least disruptive of those considered to historic resources. In response to questions posed by Mrs. Amadon, the following points were made:

A. The duration of the construction process is an important factor when evaluating the potential impact. Dom suggested that total construction would take approximately 28 months. It was pointed out, however, that restoration of the fence, landscaping and other elements of Flagstaff Park could begin well before the completion of the station complex. An estimate of this amount of time will be forthcoming from Dom D'Eramo.

B. The specific response necessary to comply with procedures set up by Section 106 of the National Historic Preservation Act need to be determined by Mrs. Amadon in her role as State Preservation Officer and Mr. Kiyoshi Mano as representative of the sponsoring Federal agency, the Urban Mass Transportation Administration of the U. S. Department of Transportation. The Draft Environmental Impact Statement cannot be considered complete until the requirements of Section 106 have been complied with. This Draft EIS is also a necessary prerequisite to a final EIS and subsequent Capital Grant for a project. Compliance with the requirements of Section 106 could take place in two ways, yet to be determined by Mrs. Amadon and Mr. Mano. These two courses of action are generally described as follows:

- A case report, in this case building upon Dom D'Eramo's information previously referenced, would be prepared by the MBTA (or their consultants) and submitted to Mrs. Amadon. Under her direction and in close coordination with Mr. Mano, a "sign-off" judgment could be given by Mrs. Amadon and Mr. Mano and a letter sent to the Adivsory Council on Historic Preservation stating that no impact, as determined by the "criteria of effect" would occur to National Register properties. The Advisory Council, upon review of the supporting case report, could then concur and the project could proceed. The sign-off would be provisional based upon certain safeguards and provisos agreed to by the MBTA. These provisos might include, for instance, review procedures whereby the state and local historical commissions could monitor and participate in the supervision of protective, mitigating and restorative measures agreed to by the MBTA.

- A second course of action would be very similar. It would begin with a finding of the Massachusetts Historical Commission that there were significant effects as determined by the criteria of effect. This finding would also be supported by a case report and submitted to the Advisory Council on Historic Preservation. In this case, however, a detailed and lengthy staff investigation would be conducted. The detailed program for protection, mitigation and restoration would then require approval of the Advisory Council. A memorandum of agreement would then be prepared between the Department of Transportation and the Advisory Council on Historic Preservation with the concurrence of the Massachusetts Historical Commission.

C. A number of specific suggestions were made. Although a sign-off letter had been obtained from Mr. Robins, the State Archaeologist, recent State laws in Massachusetts and reviewers in the Department of the Interior, warrant additional verification of the lack of archaeological resources that might be affected by the project. Mrs. Amadon praised Mr. Robin's knowledge of prehistoric archaeology but suggested that some additional verification be received from someone knowledgeable concerning the potential for historical archaeological artifacts in the Harvard Square station area. Mr. Sullivan suggested that the city's records of prior development in that vicinity were sufficiently accurate so that the Historical Commission could verify the absence of historical artifacts in the area which would be affected by construction of the subway station.

D. Mrs. Amadon emphasized the importance of representation by the Cambridge Historical Commission on the committee working with MBTA in the Harvard Square area. She cautioned that an early warning system was needed to alert the city and state historical commissions to each step in the continuing design activities in Harvard Square. Too frequently, architects and engineers invest thousands of dollars in man-hours in developing designs which do not properly consider historic resources. Protective and restorative measures are, therefore, extremely costly, and are undertaken by the sponsoring agency only with a great deal of reluctance. If the state and city historical commissions are involved in the design from the earliest phases on, most of the wasteful exercises can be avoided.

E. Mrs. Amadon noted that if a station entrance or other design feature of a station or alignment affects the setting of a structure or district on the National Register, the State Historical Commission must be consulted just as if the undertaking were, in fact, directly affecting the structure, site or district. In this instance, the entrance to the current subway station, which is integral with the fence in Flagstaff Park and the proposed entrances to the Arlington Center stations, which abut the National Register property on the northwest corner of the intersection of Mystic and Massachusetts Avenue, are two specific examples.

F. Mr. Sullivan is revising a draft of a letter which will be delivered to the MBTA, noting the concurrence of Mrs. Amadon, summarizing the reactions of the Cambridge Historical Commission to the Red Line Project. Though there is strong support for the project, and a recognition that the selected alternative is the least disruptive to

historic resources, it identifies several critical areas requiring further attention. The first of these is the protection of the kiosk in Harvard Square. A sketch prepared by the architect, Marcel Breuer as a subconsultant to Sverdrup & Parcel, who are consultants to the MBTA, shows existing kiosk totally replaced by a new station entrance. Although the kiosk was not listed in the letter sent to the MBTA consultants by the Cambridge Historical Commission as being an historic resource of the Harvard Square area, both Mrs. Amadon and Mr. Sullivan stressed the importance of keeping this symbolic and historic landmark. It was further stated that it would be most desirable if it could remain as the head for an entrance to the new Harvard Square station. The kiosk could come under the protection of at least Section 4(f) and, therefore, it would be necessary for the MBTA to demonstrate quite clearly that there was no prudent and feasible alternative to the relocation or destruction of the kiosk.

G. Mrs. Amadon expressed appreciation at the opportunity for the meeting, and was generally in concurrence with the conclusions of the MBTA studies. She cautioned, however, that this in no way was a sign-off by the State Historical Commission under Section 106 procedures. The next step is for Mr. Mano and Mrs. Amadon to prepare a joint recommendation for compliance with Section 106. Mr. Pointner and Mr. D'Eramo will prepare a draft copy of the minutes of the meeting and the MBTA will provide some additional detail for the case report. Mr. Sullivan will verify the lack of historical, archaeological potential and send Mr. D'Eramo a copy of his letter for inclusion in the environmental analysis report.

NJP:lk

PAUL GUZZI
Secretary of the Commonwealth

The Commonwealth of Massachusetts
Office of the Secretary
Massachusetts Historical Commission
294 Washington Street Boston, Massachusetts 02108
(617) 727-8470

January 16, 1976

Mr. Domenic E. D'Eramo, P.E.
Sverdrup & Parcel and Associates
648 Beacon Street
Boston, Massachusetts 02215

Re: MBTA Red line extension from Cambridge to Arlington

Dear Mr. D'Eramo:

I am writing in response to your request for comments on our meeting which took place on January 14, 1976 and included representatives of Sverdrup and Parcel, the Massachusetts Bay Transportation Authority, the Urban Mass Transportation Administration, the Cambridge Historical Commission and myself as State Historic Preservation Officer and director of the Massachusetts Historical Commission. This meeting involved the review of the preferred alternative, D-2, for the above project.

I agree that of all the alternatives presented in the draft 106 Review, dated January 6, 1976, Alternative D-2 has the least adverse effect on historic properties. The only alternative which would cause no effect is "no build", an unacceptable choice as the need for the Red Line extension and improvements has been adequately demonstrated.

These comments apply only to the proposed plans and specifications as presented to us on January 14 and to designated Alternative D-2. If alterations are made in this alternative and as it is further developed, additional review will be necessary.

I would like to make the following requests and recommendations:
<u>Cambridge</u>
1) At Harvard Square, the reconstruction of the wall bordering Harvard Yard (in the National Register Historic District) should take place at the earliest possible time in the construction period.

EXHIBIT C

2) The retention and reuse of the 1928 Subway kiosk, located at the junction of Massachusetts Avenue, Brattle and Dunster Streets in the center of the street, should be studied in depth. Any new construction located here is also subject to review for compatibility with the contiguous National Register historic district. I would like to request an opportunity for my review of this area of concern at the earliest study and design stage.

3) An engineering study should be made and all means taken to insure protection of the foundation and walls of the First Parish Unitarian Church (on the National Register).

4) In cooperation with the Cambridge Historical Commission and the Cambridge Conservation Commission, plans should be made for the type and location of any new trees to replace those which must be removed during construction in Flagstaff Park. Also, the location and design of the vent should be planned to meet the approval of the aforementioned commissions and myself.

5) The design of any street furniture and type and location of any trees removed during construction in the entire Harvard Square/Cambridge Common Historic Districts is subject to review by this office.

I recognize that there will be a short term adverse effect on the National Register districts during construction which cannot be mitigated but I also feel there is no prudent and feasible alternative to this effect. With proper review, the possible long term adverse effects can be removed or mitigated.

<u>Arlington</u>
1) The design of the proposed above ground subway station, located at the junction of Massachusetts Avenue, Pleasant and Mystic Streets, is subject to review for compatibility with the contiguous Arlington Town Center National Register Historic District. The Arlington Historical Commission and this office should be consulted at the earliest design stage.

2) The relocation of the commemorative plaque, now at the above junction, will not require my review, providing the Arlington Historical Commission is satisfied with the new location.

The above comments represent the consensus of agreement reached at the January 14 meeting. I recognize and commend the study which has gone into

this project and appreciate the willing cooperation extended to the review agencies by everyone involved in the planning.

Sincerely yours,

Elizabeth Reed Amadon

Elizabeth Reed Amadon
Executive Director
Massachusetts Historical Commission
State Historic Preservation Officer

ERA/mw

xc: John McDermott, Advisory Council
Robert Neiley, Cambridge Historical Commission
Charles Sullivan, Cambridge Historical Commission
Ki Mano, Urban Mass Transportation Administration
George Wey, Massachusetts Bay Transportation Authority

CITY OF CAMBRIDGE

CAMBRIDGE HISTORICAL COMMISSION

CITY HALL ANNEX, 57 INMAN STREET

CAMBRIDGE, MASSACHUSETTS 02139

January 30, 1976

Domenic E. D'Eramo, P. E.
Sverdrup & Parcel and Associates
648 Beacon Street
Boston, Mass. 02215

Dear Mr. D'Eramo:

I am writing, as agreed at our meeting of January 14, to review the draft "Determination of Effect on National Register Properties" of the proposed extension of the MBTA's Red Line through Harvard Square and under Massachusetts Avenue to the Somerville line. The following is a result of consultation with Elizabeth Amadon, the State Historic Preservation Officer, and represents the Commission's position with regard to the plans as they have been formulated to date.

The Draft correctly states that the entire Cambridge Common and Old Harvard Yard Districts are on the National Register. As we pointed out at the meeting, all structures and features within or surrounding a National Register District must be given equal consideration to minimize adverse effects, and all new construction similarly falls within the 106 review process. We do not feel that the temporary adverse effects to be encountered during the construction phase are grounds for extensive revision of the project, although we expect that evidence will be provided to demonstrate that these effects have been minimized.

The demolition of the present Harvard Square kiosk and the construction of such features as new headhouses, bus ramps, and ventilating shafts are specific matters of concern. The State Historic Preservation Officer and I substantially agree that the kiosk cannot be removed if a feasible and prudent alternative to its destruction exists, although this does not mean that it must continue to be used for a station entrance. The statement in the Draft that the adverse effect of "Destruction or alteration of all or part of a property" will only be a factor during the construction period is incorrect.

EXHIBIT D

I have investigated the possibility that significant archeological remains may lie in the path of the extension. It is my opinion that such remains will not be found, as almost the entire area to be disturbed for the excavation has either been a public way since the settlement of Cambridge or was dug up for the construction of the original subway. However, I expect that reasonable care will be taken in the event that unexpected remains are found.

As a procedural matter, I would like to point out that the Advisory Council procedures for review of the plans must be outlined in the draft E.I.S. These procedures, as well as the remaining steps in the review process with the Cambridge Historical Commission, the Massachusetts Historical Commission, and other public and private bodies has not, to my knowledge, been clearly outlined. In my opinion, the whole review process would be greatly facilitated if the steps that will be taken in this regard can be set out in detail.

I hope that these comments will be useful; please let me know if I can be of any further assistance.

Yours,

Charles M. Sullivan
Executive Director

CMS/dl

CC: Elizabeth Amadon,
Massachusetts Historical Commission
Kiyoshi Mano,
Urban Mass Transportation Administration

4F SITES IN HARVARD SQUARE AREA

LEGEND :

- — — CAMBRIDGE COMMON HISTORIC DISTRICT
- ········ OLD HARVARD YARD HISTORIC DISTRICT

NR ··· NATIONAL REGISTER DISTRICT
CHC ·· CAMBRIDGE HISTORIC DISTRICT
NHL ·· NATIONAL HISTORIC LANDMARK
NRS · NATIONAL REGISTER SITE

HISTORIC SITES:

1	WADSWORTH HOUSE	NR
2	LEHMAN HALL	NR
3	STRAUS HALL	NR
4	MASSACHUSETTS HALL	NR,NHL,CHC
5	HARVARD HALL	NR,CHC
6	LIONEL HALL	NR
7	GANNET HOUSE	NR,CHC
8	HASTING HALL	NR,CHC
9	HARVARD-EPWORTH CHURCH	NR,CHC
10	FIRST PARISH CHURCH UNITARIAN	NR,CHC
11	CHRIST CHURCH	NR,NHL,CHC
12	1 GARDEN ST.	NR,CHC
13	FAY HOUSE	NR,CHC
14	LONGFELLOW HALL	
15	77 BRATTLE STREET	
16	42 BRATTLE STREET	NRS
17	54 BRATTLE STREET	NRS
18	76 BRATTLE STREET (GREENLEAF HOUSE)	
	CAMBRIDGE COMMON	
	OLD BURYING GROUND	

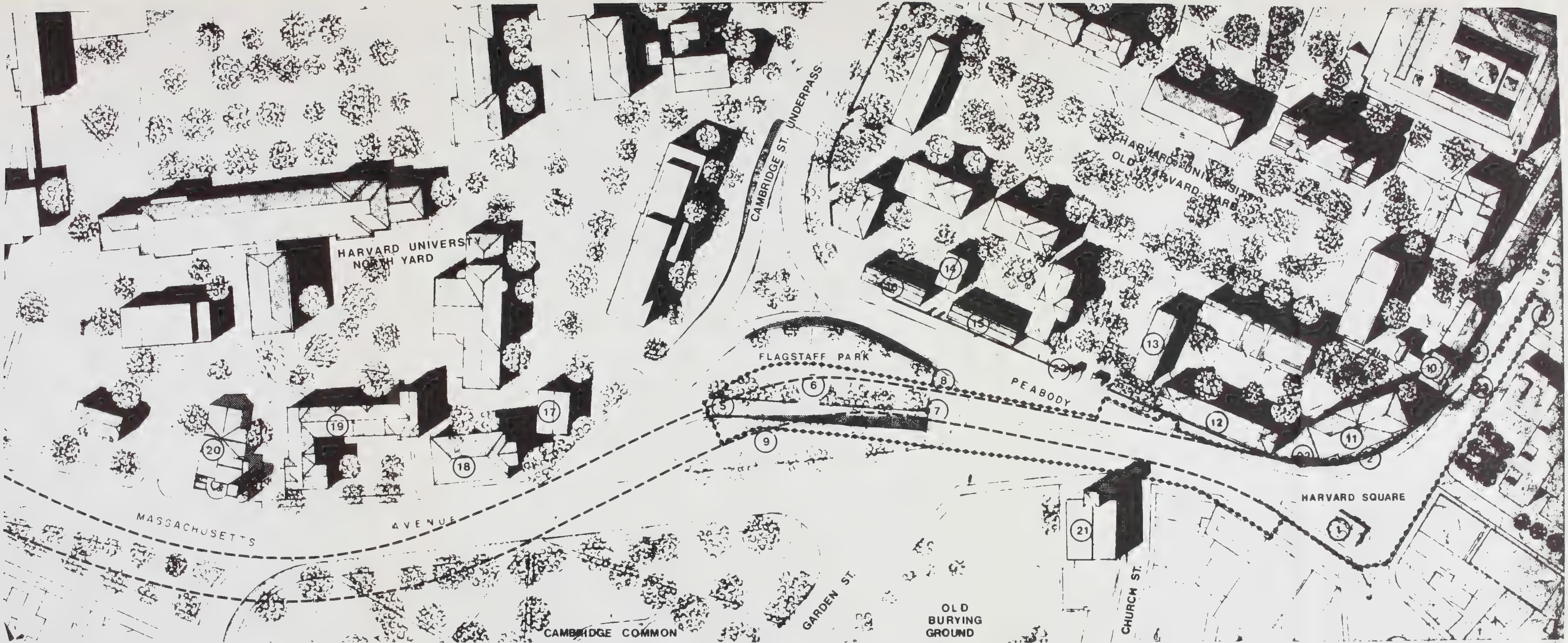
PARK RECREATIONAL SITES:

CAMBRIDGE COMMON
FLAGSTAFF PARK
NORTH LITTLE COMMON

Massachusetts Bay Transportation Authority

HARVARD SQUARE
EXISTING CONDITIONS

EXHIBIT E



EXISTING SUBWAY

1 KIOSK
2 ENTRANCE AT LEHMAN HALL
3 ENTRANCE AT HOLYOKE CENTER
4 EXIT NEAR WADSWORTH HOUSE
5 BUS INCLINE

FLAGSTAFF PARK

6 FLAGPOLE
7 STATUE
8 TERRACE
9 PARKING

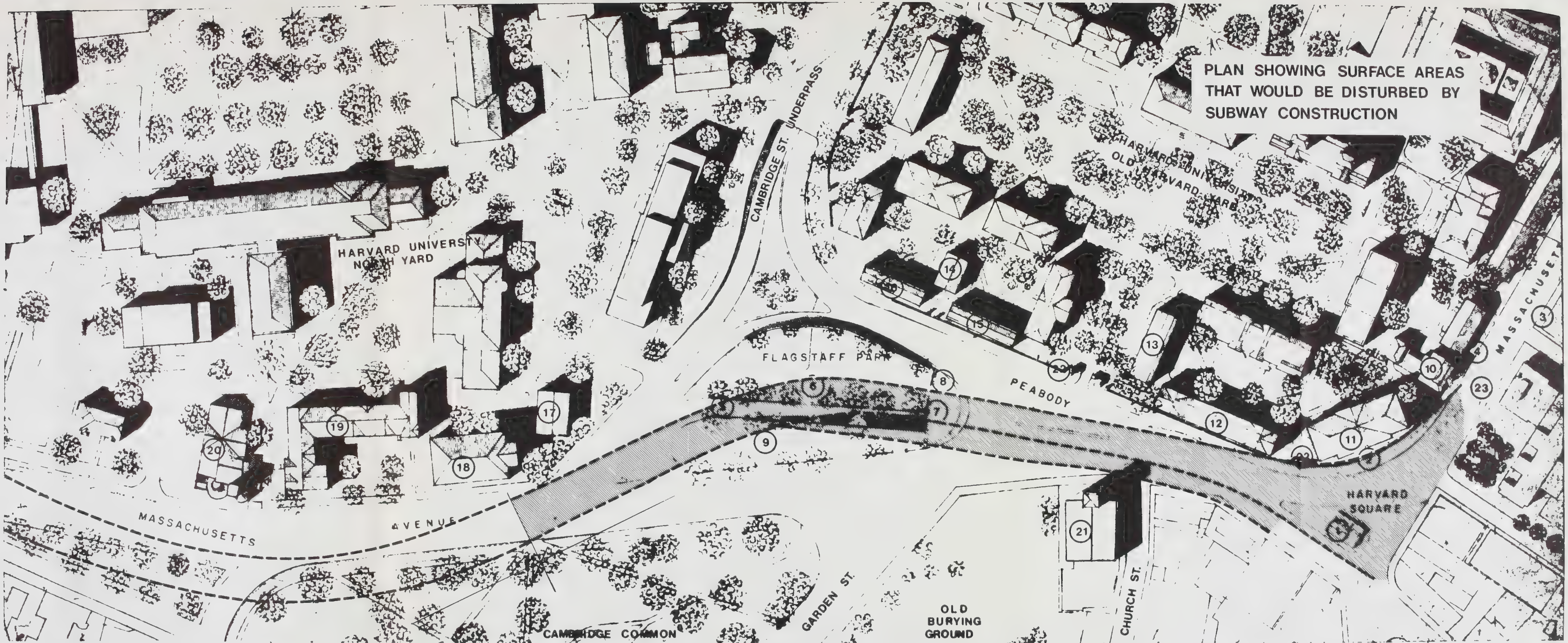
BUILDINGS IN N.R. DISTRICTS NEAR PROPOSED UNDERTAKING

10 WADSWORTH HOUSE
11 LEHMAN HALL
12 STRAUS HALL
13 MASSACHUSETTS HALL
14 HOLDEN CHAPEL
15 LIONEL HALL
16 MOWER HALL
17 GANNETT HOUSE
18 HEMENWAY GYM
19 HASTING HALL
20 HARVARD-EPWORTH METHODIST CHURCH
21 FIRST CHURCH UNITARIAN

MISCELLANEOUS

22 MEMORIAL FENCE
23 BRASS PLATES
◆◆◆◆◆ LIMIT OF CONSTRUCTION

EXHIBIT F



EXISTING SUBWAY
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4 EXIT NEAR WADSWORTH HOUSE
5 BUS INCLINE

FLAGSTAFF PARK
6 FLAGPOLE
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8 TERRACE
9 PARKING

BUILDINGS IN N.R. DISTRICTS NEAR PROPOSED UNDERTAKING
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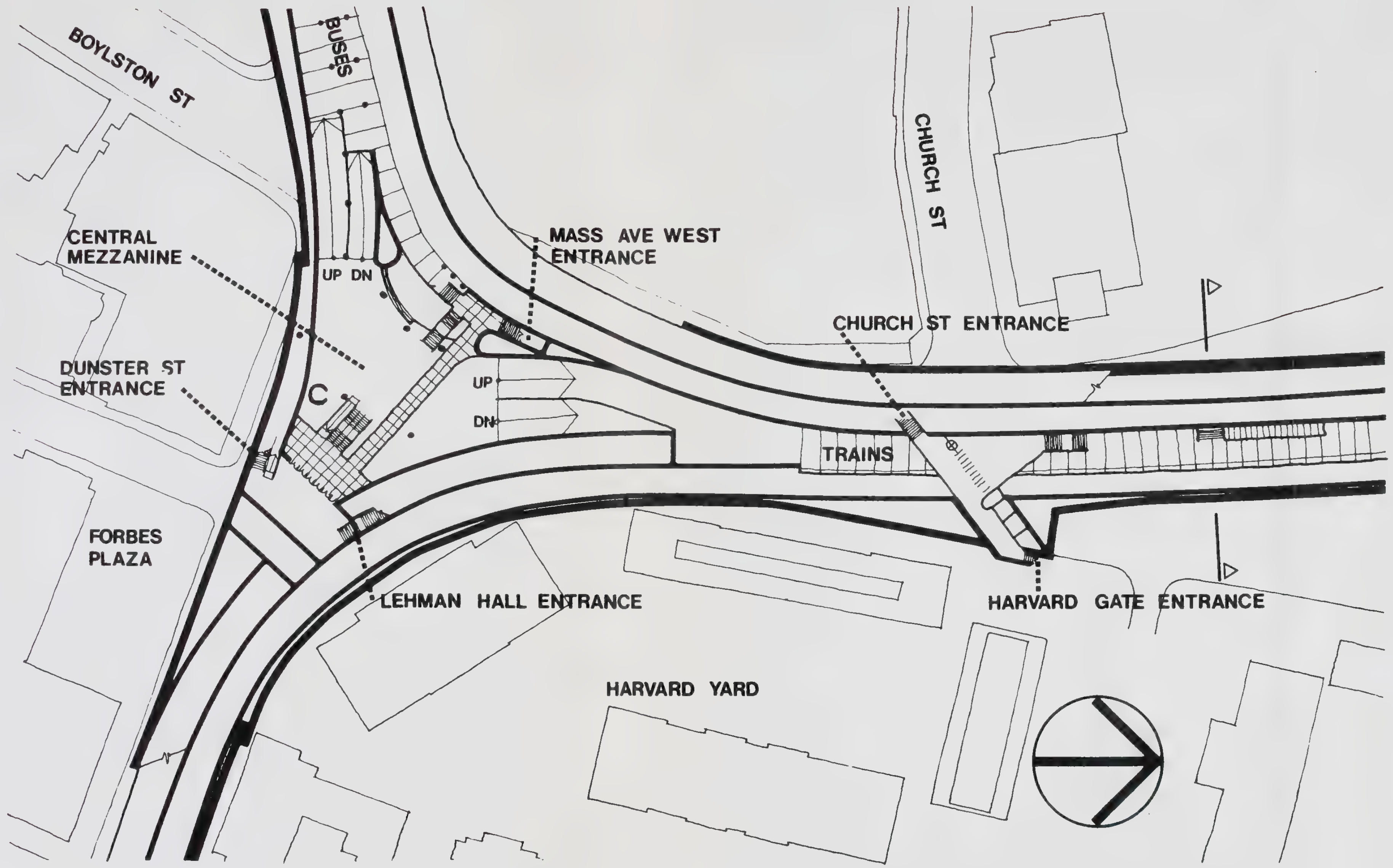
11 LEHMAN HALL
12 STRAUS HALL
13 MASSACHUSETTS HALL
14 HOLDEN CHAPEL
15 LIONEL HALL
16 MOWER HALL
17 GANNETT HOUSE
18 HEMENWAY GYM
19 HASTING HALL
20 HARVARD-EPWORTH METHODIST CHURCH
21 FIRST CHURCH UNITARIAN

MISCELLANEOUS
22 MEMORIAL FENCE
23 BRASS PLATES

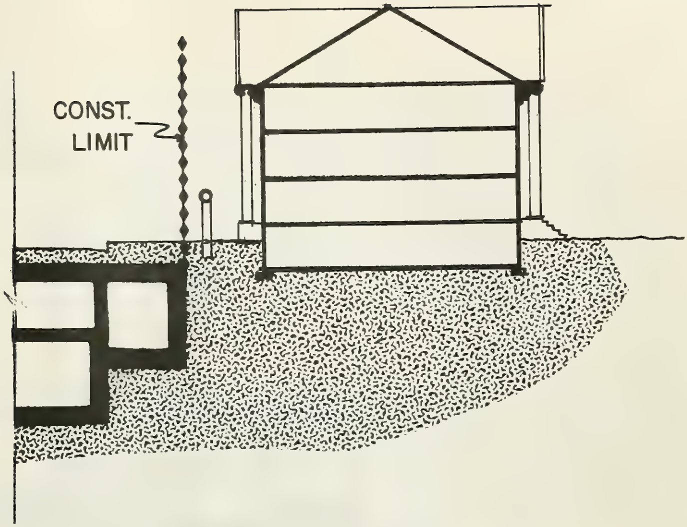
EXHIBIT G



Source: Skidmore, Owings & Merrill

EXHIBIT I DELETED

EXHIBIT I



DIAGRAMMATIC CROSS SECTIONS

ABOVE: AT LEHMAN HALL

BELOW: AT STRAUS HALL

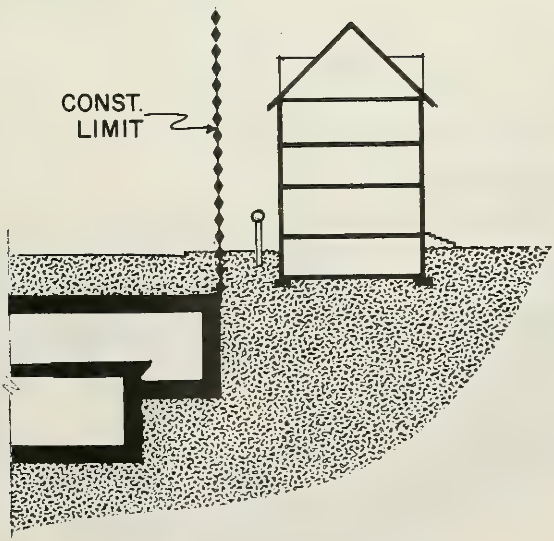
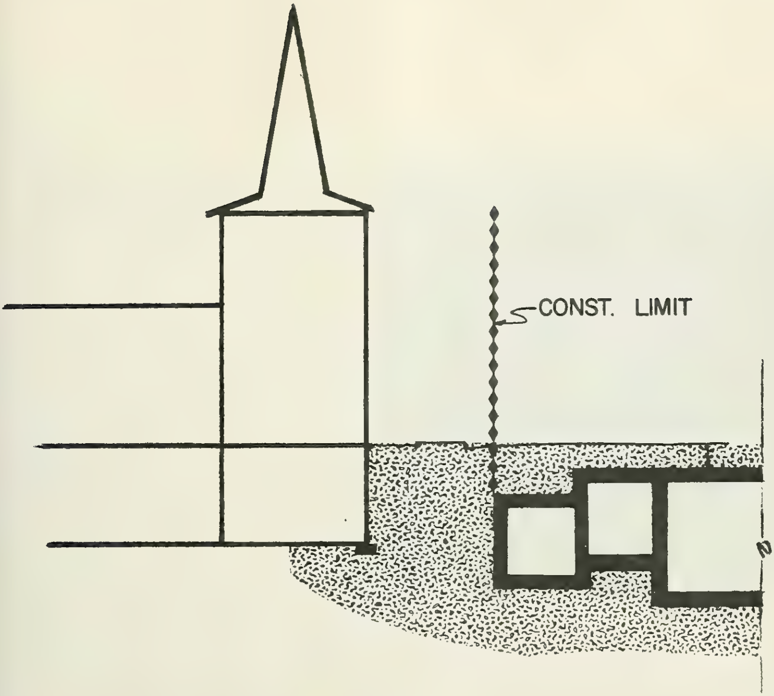


EXHIBIT J-1



DIAGRAMMATIC CROSS SECTIONS

ABOVE: AT FIRST CHURCH UNITARIAN

BELOW: AT HEMMENWAY GYMNASIUM

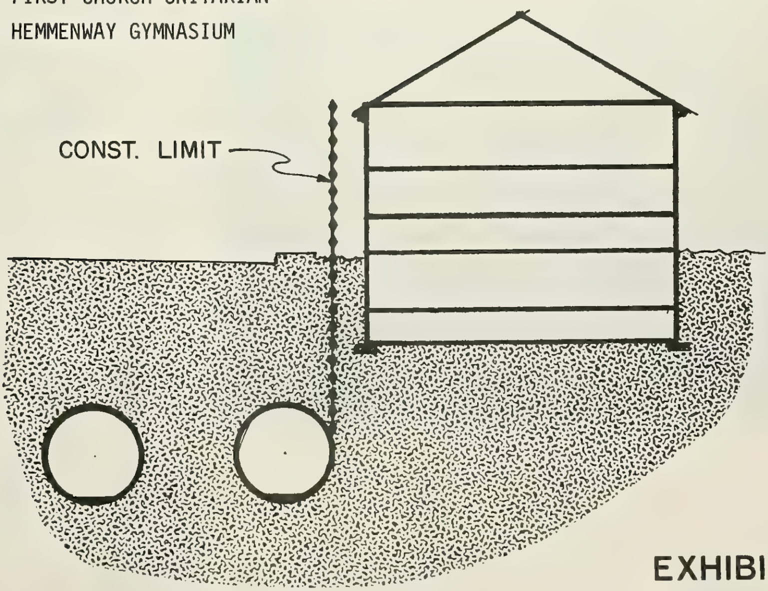


EXHIBIT J-2

View of
Harvard Square

Harvard Square looking toward Harvard Yard. Lehman, Strauss and Mathews Halls are in background. Subway Kiosk and newsstand are at center.

EXHIBIT K-1

View of subway entrance in fence at Lehman Hall.

Subway entrance at Wadsworth House (lower right)

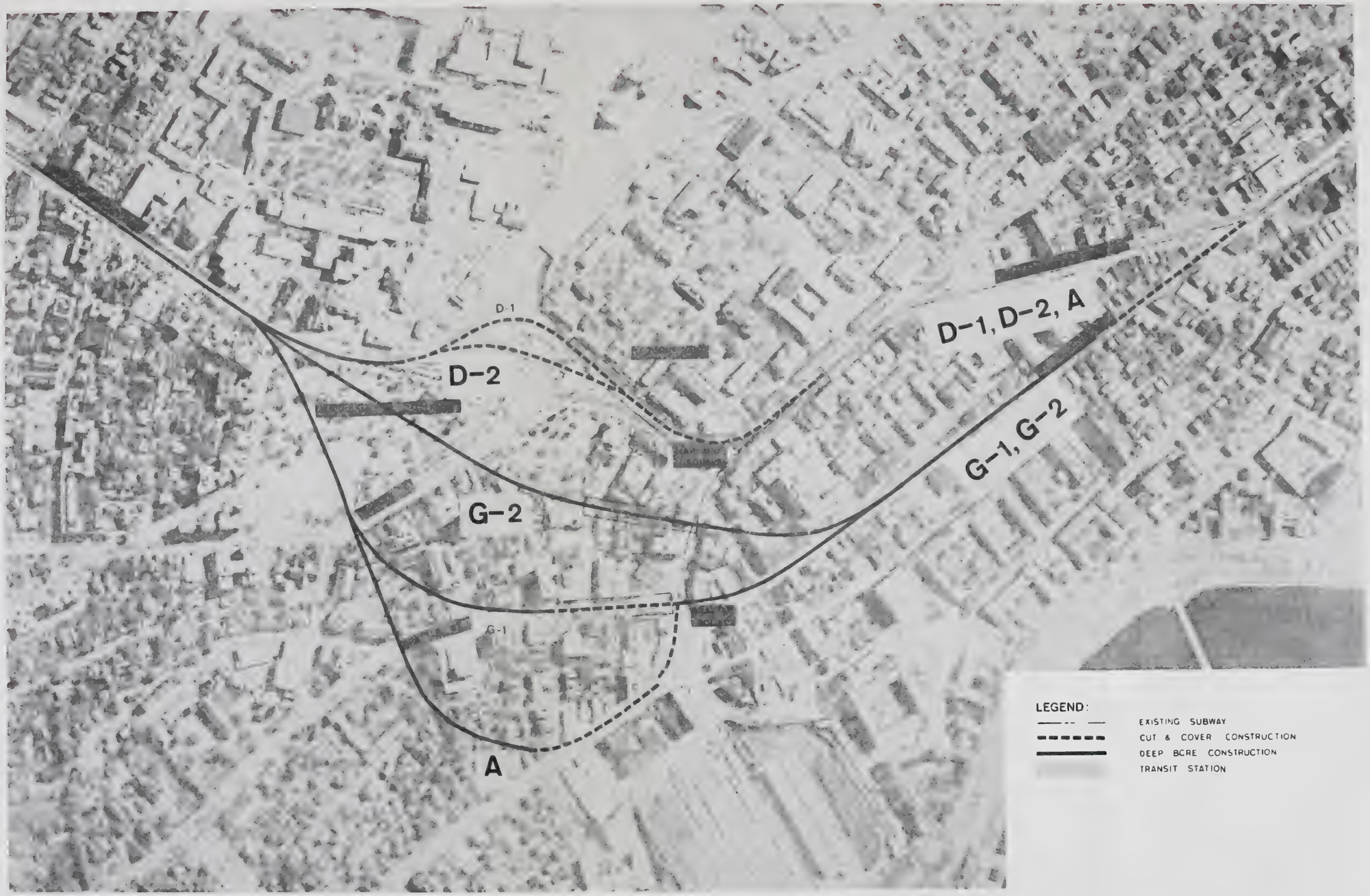
EXHIBIT K-2

Harvard Square looking toward Lehman Hall. Fencing and gate would be temporarily removed to construct new tunnels.

Statue of General Sumner, terrace and wall in Flagstaff Park. These would be removed and restored during subway construction.

Flagpole in Flagstaff Park. Pole would be temporarily removed. Trees on the left would be replaced.

EXHIBIT K-4



Massachusetts Bay Transportation Authority

HARVARD SQUARE
ALTERNATIVE ALIGNMENTS

FEET

EXHIBIT L

LONG TERM (OPERATIONAL)	LINE A	LINE D-1 (D-2) PROJECT	LINE G-1	LINE G-2
A. RAPID TRANSIT CRITERIA				
1. GEOMETRICS	CURVES RANGING FROM 320 FT. TO 480 FT. RADII ARE BELOW DESIRABLE STANDARDS (500' MIN. RADIUS)--INCREASES TRACK MAINTENANCE, AND RESTRICTS OPERATING SPEEDS. GRADE IS SLIGHTLY STEEPER THAN DESIRABLE 3%. DEFINITE WHEEL SQUEAL AT HARVARD SQUARE, ELIOT SQUARE AND HILLIARD ST., BUT INTENSITY CAN BE CONTROLLED.	D-1 ALIGNMENT REQUIRES CURVES OF 250 FT. AND 350 FT. RADII--ALL BELOW DESIRABLE STANDARD OF 500 FT. MIN. RADIUS--INCREASES TRACK MAINTENANCE AND RESTRICTS OPERATING SPEEDS. STATION IS ON 1/2% GRADE VS. DESIRABLE LEVEL PROFILE. DEFINITE WHEEL SQUEAL AT HARVARD SQUARE AND FLAGSTAFF PARK, BUT INTENSITY CAN BE CONTROLLED. D-2 IS SIMILAR BUT FLATTER CURVES NORTH OF STATION IMPROVES GEOMETRICS.	FAIRLY "SMOOTH" ALIGNMENT. NO SUBSTANDARD CURVES OR GRADES, BUT CURVES WILL RESTRICT OPERATING SPEEDS. WHEEL SQUEAL IS PROBABLE AT EACH END OF STATION BUT INTENSITY CAN BE CONTROLLED.	BEST GEOMETRY OF ALTERNATIVES STUDIED. NO SUBSTANDARD CURVES OR GRADES. AFFECT ON OPERATING SPEED IS MINIMAL. POSSIBLE WHEEL SQUEAL EACH END OF STATION BUT INTENSITY CAN BE CONTROLLED.
2. RUNNING TIME (CENTRAL SQ.) (TO) (PORTER SQ.)	4 MINUTES 40 SECONDS	4 MINUTES 23 SECONDS (D-1) 4 MINUTES 17 SECONDS (D-2)	4 MINUTES 17 SECONDS	4 MINUTES 0 SECONDS
3. INTERFACE WITH BUS SERVICE	EXISTING UNDERGROUND ARRANGEMENT UNCHANGED. INTERCONNECTION IS GENERALLY DIRECT BUT SPATIALLY CONFUSING.	EXISTING UNDERGROUND BUSWAYS USED. (WAITING SPACES MODIFIED.) BUS PASSENGER AREAS ARE PHYSICALLY AND VISUALLY INTEGRATED WITH TRANSIT MEZZANINE LEVELS. MOST DIRECT RELATIONSHIP OF STATION ALTERNATES STUDIED.	COMPARABLE TO G-2. HORIZONTAL DISTANCES BETWEEN TRANSIT MODES ARE SOMEWHAT GREATER BUT VERTICAL DISTANCES ARE LESS.	EXISTING UNDERGROUND BUSWAYS USED. (WAITING SPACES MODIFIED AND CENTERED NEAR PALMER STREET.) ADJOINING TUNNEL SPACE FROM KIOSK AREA TO BRATTLE SQ. BECOMES "FREE" CONCOURSE. CONCEPT REQUIRES TWO OR MORE VERTICAL MOVEMENTS TO REACH TRAIN LEVEL FROM BUS AREAS, BUT MOVEMENTS ARE UNCOMPLICATED.
4. CROSSOVER PROVISIONS	EXISTING CROSSOVER PROVISIONS RETAINED.	CROSSOVER PROVIDED NORTH OF NEW STATION.	CROSSOVER FEASIBLE BUT NOT PLANNED. WOULD REQUIRE ADDITIONAL CUT-AND-COVER WORK TO GUTMAN LIBRARY.	NONE PLANNED. IMPRACTICAL IN DEEP-BORE CONSTRUCTION.
5. TRAIN STORAGE	CAN BE IN EXISTING TUNNEL FROM BRATTLE SQUARE TO ELIOT YARD PORTAL.	INBOUND TRACK CONNECTION TO EXISTING TUNNEL WEST OF HARVARD SQUARE REMAINS. TUNNEL COULD BE UTILIZED FOR TRAIN STORAGE.	BOTH TRACKS COULD MAINTAIN DIRECT CONNECTION TO EXISTING TRANSIT AT PUTNAM SQUARE. POSSIBLE TO USE THIS TUNNEL FOR TRAIN STORAGE.	SAME AS G-1
6. LAYUP TRACK	CAN BE IN EXISTING TUNNEL FROM BRATTLE SQUARE TO ELIOT YARD PORTAL.	USE OF ONE TRACK IN ABANDONED TUNNEL IS PROPOSED. A LAY-UP TRACK NORTH OF STATION IS PREFERABLE BUT IS NOT PLANNED.	POSSIBLE TO USE ABANDONED TRACKAGE WEST OF PUTNAM SQUARE. A LAYUP TRACK NORTH OF STATION IS PREFERABLE BUT IS NOT PLANNED.	SAME AS G-1
B. BUS SERVICE				
1. THROUGH ROUTES AND TERMINUS ROUTES	TRANSIT EXTENSION WILL REDUCE DAILY BUS VOLUME BY ABOUT 50%. THROUGH-ROUTING OF ALL LINES, WITH NO HOLDOVER, IS PROPOSED. THE EXCEPTION IS THE DUDLEY STATION ROUTE WHICH WILL TERMINATE AND RETURN.	SAME AS A	SAME AS A	SAME AS A
C. PASSENGER POTENTIAL				
1. RAPID TRANSIT STATION / BUS PLATFORM	CLOSE TO CENTERS OF PROJECTED EMPLOYMENT AND RESIDENT POPULATION WITHIN A 1/2 MILE RADIUS.	CLOSE TO CENTERS OF PROJECTED EMPLOYMENT AND 1/2 MILE POPULATION RADIUS.	CLOSEST TO PROJECTED EMPLOYMENT CENTER AND 1/4 MILE POPULATION CENTER.	CLOSEST TO CENTER OF COMMERCIAL FLOOR SPACE AND PROJECTED 1/4 MILE POPULATION RADIUS.
D. IMPACTS				
1. SURFACE TRAFFIC {PEDESTRIAN, VEHICULAR, BICYCLE}	MAIN ENTRANCE MUST REMAIN AT OR NEAR PRESENT LOCATION. PEDESTRIAN-VEHICULAR CONFLICT COULD BE REDUCED BY MODIFYING STREET PATTERNS AND ANNEXING ENTRANCE TO EITHER THE SOUTH OR WEST SIDES OF THE SQUARE. CONSIDERABLE STREET AREA COULD THEREBY CONVERT TO PEDESTRIAN SPACE.	EXISTING KIOSK AND ISLAND CAN BE ELIMINATED. ENTRANCES IN HARVARD SQUARE ARE POSSIBLE AT PERIPHERAL LOCATIONS AND IN BRATTLE STREET (NEAR PALMER). MODIFIED TRAFFIC PATTERNS AND ENLARGED PEDESTRIAN AREAS ARE NEEDED FOR OPTIMUM EFFECTIVENESS.	TWO OR MORE ENTRANCES REQUIRED ALONG HARVARD SQUARE-BRATTLE SQUARE AXIS. ACCESS LOCATIONS ARE ADAPTABLE TO PRESENT TRAFFIC PATTERNS (WITH SOME MODIFICATION OF CURB LINES), BUT CLOSING OF BRATTLE STREET FROM CHURCH STREET TO KIOSK AREA WOULD PROVIDE BETTER DESIGN OPTIONS ABOVE AND BELOW GROUND.	SAME AS G-1, EXCEPT MAIN ENTRANCE WOULD BE OFF-STREET (CORNER OF BRATTLE AND PALMER STREET).
2. SOCIO-ECONOMIC CONDITIONS	SEE CHAPTER V			
3. BUILDINGS / RESIDENCES	LINE CROSSES UNDER OR ADJACENT SENSITIVE BUILDINGS SUCH AS HARVARD DORMS ALONG MASSACHUSETTS AVE., HILLIARD ST. RESIDENCES, LOEB DRAMA CENTER, RADCLIFFE YARD BUILDINGS AND EPWORTH CHURCH. <u>EXTENSIVE</u> NOISE AND VIBRATION CONTROLS ARE NECESSARY.	LINE IS ADJACENT TO SEVERAL SENSITIVE BUILDINGS SUCH AS HARVARD DORMS ALONG MASSACHUSETTS AVE. AND PEABODY ST., THE LITTAUER CENTER, GANNETT HOUSE, EPWORTH CHURCH, AND THE UNITARIAN CHURCH. <u>INTERMEDIATE</u> NOISE AND VIBRATION CONTROLS ARE NECESSARY BUT <u>LEAST OF</u> ALTERNATES STUDIED.	LINE CROSSES UNDER OR ADJACENT SENSITIVE BUILDINGS SUCH AS ST. PAUL'S CHURCH, BRATTLE THEATER AREA, LOEB DRAMA CENTER, RADCLIFFE YARD BUILDINGS, GUTMAN LIBRARY, AND EPWORTH CHURCH. <u>EXTENSIVE</u> NOISE AND VIBRATION CONTROLS ARE NECESSARY.	LINE CROSSES UNDER OR ADJACENT SENSITIVE BUILDINGS SUCH AS ST. PAUL'S CHURCH, CHRIST CHURCH AND EPWORTH CHURCH. <u>INTERMEDIATE</u> NOISE AND VIBRATION CONTROLS ARE NECESSARY.
4. HISTORIC SITES	ALIGNMENT CROSSES UNDER FAY HOUSE AND BYERLY HALL BOTH WITHIN THE CAMBRIDGE COMMON HISTORIC DISTRICT/NATIONAL REGISTER OF HISTORIC PLACES. EXTENSIVE NOISE AND VIBRATION CONTROLS ARE NECESSARY TO NEGATE IMPACTS.	ALIGNMENT IS WITHIN THE CAMBRIDGE COMMON HISTORIC DISTRICT, AND ADJACENT TO THE OLD HARVARD YARD HISTORIC DISTRICT, BOTH ON THE NATIONAL HISTORIC REGISTER. INTERMEDIATE NOISE AND VIBRATION CONTROLS ARE NECESSARY.	ALIGNMENT CROSSES UNDER FAY HOUSE AND BYERLY HALL BOTH WITHIN THE CAMBRIDGE COMMON HISTORIC DISTRICT/NATIONAL REGISTER OF HISTORIC PLACES AND ADJACENT TO OTHER NATIONAL HISTORIC SITES AS THE WILLIAM BRATTLE HOUSE AND THE VILLAGE BLACKSMITH. SEVERAL SITES OF LOCAL HISTORICAL SIGNIFICANCE SUCH AS ST. PAUL'S CHURCH, LAMPOON BUILDING AND LONGFELLOW HALL ADJACENT TO THE ALIGNMENT. EXTENSIVE NOISE AND VIBRATION CONTROLS ARE NECESSARY.	ALIGNMENT CROSSES UNDER CHRIST CHURCH WHICH IS WITHIN THE CAMBRIDGE COMMON HISTORIC DISTRICT/NATIONAL REGISTER OF HISTORIC PLACES. SEVERAL SITES OF LOCAL SIGNIFICANCE ADJACENT TO ALIGNMENT SUCH AS ST. PAUL'S CHURCH, LAMPOON BUILDING, 31 CHURCH STREET (FORMER POLICE STATION) AND 26 CHURCH STREET. INTERMEDIATE NOISE AND VIBRATION CONTROLS ARE NECESSARY.
5. RECREATION AREAS	ALIGNMENT CROSSES UNDER CAMBRIDGE COMMON. NO ADVERSE IMPACT IS ANTICIPATED.	AN EMERGENCY EXIT PRESENTLY CONTEMPLATED WITHIN FLAGSTAFF PARK. POTENTIAL FOR COMBINED EAST-WEST BUS STOP AND TRANSIT ENTRANCE.	THE ALIGNMENT CROSSES UNDER CAMBRIDGE COMMON AND ADJACENT TO WINTHROP SQUARE. NO ADVERSE IMPACT IS ANTICIPATED.	ALIGNMENT CROSSES UNDER CAMBRIDGE COMMON. NO ADVERSE IMPACT IS ANTICIPATED.
6. ECOLOGY	NO ADVERSE ECOLOGIC IMPACT IS ANTICIPATED.	LOSS OF TREES IN FLAGSTAFF PARK UNDER D-2	SAME AS A	SAME AS A

EXHIBIT M-1

Massachusetts Bay Transportation Authority

HARVARD SQUARE
AREA ALTERNATIVES
SUMMARY OF IMPACTS

SHORT TERM (CONSTRUCTION)	LINE A	LINE D-1 (D-2) PROJECT	LINE G-1	LINE G-2
A. IMPACTS				
1. TRANSIT (RAIL) SERVICE	RAIL SERVICE INTERRUPTED IN MAKING CONNECTION TO EXISTING TRACKS AT BRATTLE SQUARE AND EXTENDING PLATFORMS. WORK COULD BE ACCOMPLISHED DURING OFF-PEAK PERIODS EITHER AT NIGHT OR A WEEKEND. SOME "SLOW DOWN" IN OPERATION FOR ABOUT 8 MONTHS.	PROPER CONSTRUCTION SCHEDULING NECESSARY TO MAINTAIN TWO-TRACK SERVICE. OFF-HOUR WORK WITHIN THE TUNNEL AND TRANSIT SERVICE STOPPAGE LIMITED TO ONE OR TWO WEEKENDS/HOLIDAYS.	RAIL SERVICE INTERRUPTED IN MAKING CONNECTION TO EXISTING TRACKS AT PUTNAM SQUARE. [illegible] OFF-PEAK HOURS. SOME DISRUPTION IN THE EXISTING BRATTLE SQUARE TUNNEL BUT SHOULD NOT AFFECT SERVICE.	SAME AS G-1
2. BUS SERVICE	PRESENT LEVEL OF SERVICE CAN BE MAINTAINED. CUT-AND-COVER TUNNEL WORK NEAR THE MT. AUBURN STREET INCLINE WILL CREATE TEMPORARY CONFLICTS.	BUS SERVICE UNDERGROUND CAN BE RETAINED DURING MOST OF CONSTRUCTION PERIOD. NORTHBOUND (UPPER) BUS TUNNEL WILL BE OUT OF USE FOR ABOUT 6 MONTHS AND ALTERNATE ROUTINGS TO OTHER TRANSIT STATIONS AND STOPS WILL BE REQUIRED. PASSENGER STOPS ON THE SURFACE IN HARVARD SQUARE MUST BE RELOCATED TO OTHER AREAS SUCH AS BRATTLE STREET AND CAMBRIDGE COMMON. D-2 IMPACTS ARE SIMILAR EXCEPT BUS TUNNEL USE WOULD BE CURTAILED IN TOTAL FOR ABOUT 12 MONTHS.	MINIMAL INTERFERENCE WITH USE OF BUSWAY TUNNELS. RENOVATION OF EXISTING TUNNEL SPACES WILL CAUSE TEMPORARY INCONVENIENCE TO BUS PASSENGERS. LEVEL OF SERVICE UNAFFECTED.	SAME AS G-1
3. PASSENGER FACILITIES	MINOR INCONVENIENCES TO PASSENGERS DURING STATION MODERNIZATION WORK. PLATFORM EXTENSIONS WILL NOT INTERFERE WITH TRAIN BOARDINGS.	TEMPORARY TWO LEVEL STATION AND KIOSK REQUIRED OPPOSITE EXISTING PLATFORMS. TRANSFER TO BUSSES WOULD BE VIA SURFACE TO EXISTING KIOSK AND DOWN TO BUSWAYS. VARYING ACCESS AND CIRCULATION IMPROVISATIONS THROUGH CONSTRUCTION AREAS WILL CAUSE SOME INCONVENIENCE TO TRAIN/BUS PATRONS.	NO IMPORTANT AFFECT ON EXISTING FUNCTIONS UNTIL NEW STATION IS IN SERVICE. REMODELING OF ABANDONED TUNNELS MAY INCONVENIENCE BUS PASSENGERS.	SAME AS G-1
4. SURFACE TRAFFIC {PEDESTRIAN, VEHICULAR, BICYCLE	DISRUPTION TO VEHICULAR TRAFFIC IN THE CUT-AND-COVER SECTIONS ON MT. AUBURN ST. BETWEEN HILLIARD ST. AND BRATTLE SQ., AND MASSACHUSETTS AVE. BETWEEN HOLYOKE AND LINDEN STREETS. TWO MOVING LANES CAN BE MAINTAINED WITH NO PARKING. PEDESTRIANS ABLE TO WALK ALONG THE AREA BEING INCONVENIENCED BY WORK. RELOCATION OF KIOSK, IF IMPLEMENTED WILL DISRUPT MASSACHUSETTS AVE. TRAFFIC.	THREE AREAS OF SURFACE CONSTRUCTION AFFECT VEHICULAR MOVEMENT AND PARKING: (1) TEMPORARY STATION (NEAR HOLYOKE CENTER). (2) NEW SUBWAY TUNNEL FROM ABOUT HOLYOKE STREET ALONG HARVARD YARD TO CAMBRIDGE ST. AND MASSACHUSETTS AVE. AT THE COMMON. (3) RESTRUCTURING EXISTING TUNNEL IN KIOSK AREA TO ACCOMMODATE PASSENGER TRANSFER FACILITIES. IT IS PROPOSED TO REROUTE AS MUCH TRAFFIC AS POSSIBLE FROM THE AREA BY USING TRAFFIC ENGINEERING TECHNIQUES SUCH AS ONE-WAY STREETS, INTERSECTION CONTROLS. A MINIMUM OF TWO MOVING TRAFFIC LANES WILL BE MAINTAINED IN HARVARD SQUARE AT ALL TIMES. CONSTRUCTION WILL BE STAGED IN SEGMENTS COMPATIBLE WITH TRAFFIC MOVEMENTS. PEDESTRIAN MOVEMENT ALONG HARVARD YARD WEST FENCE ELIMINATED DURING CONSTRUCTION. PEDESTRIAN MOVEMENT IN THE SQUARE INCONVENIENCED. D-2 SIMILAR EXCEPT NEW BUS TUNNEL BETWEEN CHURCH STREET AND FLAGSTAFF PARK WILL BE BUILT AND SUBWAY WORK WILL BE WITHIN FLAGSTAFF PARK AND NOT ON PEABODY STREET.	TWO MAJOR AREAS OF SURFACE DISRUPTION: (1) BRATTLE STREET BETWEEN THE SQUARE AND STORY STREET. DESIRABLE TO ELIMINATE VEHICULAR TRAFFIC FROM THIS AREA FOR THE CONSTRUCTION PERIOD. PROVISIONS FOR SERVICE VEHICLES AND THE LIKE CAN BE MADE. PEDESTRIAN TRAFFIC INCONVENIENCED BY THE CONSTRUCTION WHICH WILL EXTEND FROM BUILDING LINE TO BUILDING LINE. PEDESTRIAN WAYS. ACCESS TO STORES MAINTAINED THROUGH PROPER PHASING OF THE WORK. (2) FROM PUTNAM SQ. TO ABOUT ATHENS ST. ALONG MT. AUBURN. CUT-AND-COVER WORK IN THIS AREA. ACCESS SHAFT FOR THE DEEP-BORE TUNNEL CONSTRUCTED EAST OF ATHENS ST. THIS REQUIRES CLOSING MT. AUBURN ST. IN THIS AREA FOR THE TOTAL LENGTH OF CONSTRUCTION--APPROXIMATELY 2 YEARS. ISOLATED CONSTRUCTION WORK WHERE BUILDINGS UNDERPINNED. SOME DISRUPTION AROUND THE PARTICULAR STRUCTURE.	THREE AREAS OF DISRUPTION: (1) FROM PUTNAM SQ. TO ABOUT ATHENS ST. ALONG MT. AUBURN ST. CUT-AND-COVER WORK IN THIS AREA. ACCESS SHAFT FOR THE DEEP-BORE TUNNEL CONSTRUCTED EAST OF ATHENS ST. THIS REQUIRES CLOSING MT. AUBURN ST. IN THIS AREA FOR THE TOTAL LENGTH OF CONSTRUCTION--APPROXIMATELY 2 YEARS. (2) PALMER AND BRATTLE STREETS. CONSTRUCTION OF STATION FACILITIES WILL TAKE PLACE OFF THE PAVED STREETS EXCEPT FOR WHATEVER WIDTH OF BRATTLE ST. USED BY CONSTRUCTION EQUIPMENT. (3) CHURCH AND PALMER STREETS, CHURCH ST. GARAGE. THIS LOCATION WILL SERVE AS THE ACCESS SHAFT FOR THE TUNNELING OF THE STATION. ISOLATED CONSTRUCTION WORK WHERE BUILDINGS UNDERPINNED. SOME DISRUPTION AROUND THE PARTICULAR STRUCTURE.
5. SOCIO-ECONOMIC CONDITIONS	SEE MAJOR ISSUES SECTION-THIS BROCHURE			
6. LAND TAKINGS / EASEMENTS	REQUIRES ACQUISITION OF PROPERTY AT 129 MT. AUBURN STREET. PERMANENT EASEMENTS FROM 15 PROPERTIES LOCATED BETWEEN MT. AUBURN STREET AND THE CAMBRIDGE COMMON.	A STRIP OF LAND WILL BE TAKEN FROM HARVARD YARD IN FRONT OF LEHMAN HALL BETWEEN WADSWORTH HOUSE AND STRAUSS HALL.	NO LAND TAKING IS REQUIRED. PERMANENT EASEMENTS REQUIRED FROM 24 PROPERTIES BETWEEN PUTNAM SQ. AND BRATTLE SQ. AND FROM GUTMAN LIBRARY THROUGH RADCLIFFE YARD.	TWO PROPERTIES TAKEN--CHURCH STREET GARAGE AND ZUM-ZUM RESTAURANT AT PALMER AND BRATTLE STREET. PERMANENT EASEMENTS REQUIRED FROM 31 PROPERTIES BETWEEN PUTNAM SQUARE AND THE CAMBRIDGE COMMON.
7. BUILDINGS / RESIDENCES	A NUMBER OF STRUCTURES AFFECTED BY THE CONSTRUCTION. TWO CATEGORIES OF STRUCTURES HAVE BEEN IDENTIFIED (1) MAJOR STRUCTURES REQUIRING UNDERPINNING: IN THIS GROUPING INCLUDES LOEB DRAMA CENTER, SCHLESINGER LIBRARY, FAY HALL, BYERLY HALL (2) MINOR STRUCTURES WHERE UNDERPINNING IS QUESTIONABLE DUE TO THE TYPE OF FOUNDATION AND STRUCTURE; THIS GROUPING INCLUDES WOOD FRAME RESIDENCES ALONG MT. AUBURN STREET (NOS. 131 AND 133), HILLIARD STREET (13, 13-1/2, 15, 17, 18 AND 20) AND FULLER PLACE (55, 56 AND 65) AND BUCKINGHAM. SEE MAJOR ISSUES DISCUSSION.	ALL BUILDINGS ADJACENT TO THE CONSTRUCTION WILL BE PROTECTED TO PREVENT ANY MOVEMENT. STRUCTURES WHERE UNDERPINNING IS QUESTIONABLE INCLUDES EPWORTH CHURCH, ROSCOE POUND BUILDING, WIETH HALL AND EVERETT ST. GARAGE. SEE MAJOR ISSUES DISCUSSION.	A NUMBER OF STRUCTURES AFFECTED BY THE CONSTRUCTION. TWO CATEGORIES OF STRUCTURES HAVE BEEN IDENTIFIED: (1) MAJOR STRUCTURES REQUIRING UNDERPINNING; THIS GROUP INCLUDES ST. PAUL'S CHURCH, LAMPOON BUILDING, THE GARAGE, 1039 MASS. AVE., HOLYOKE CENTER, 95-101 MT. AUBURN ST., 2 MT. AUBURN ST., 25 MT. AUBURN ST., DESIGN RESEARCH, GUTMAN LIBRARY, QUINCY HOUSE DORM, LONGFELLOW HALL, FAY HOUSE, BYERLY HOUSE, 60 BRATTLE ST., and 51 MT. AUBURN ST. (2) MINOR STRUCTURES WHERE UNDERPINNING IS QUESTIONABLE DUE TO THE TYPE OF STRUCTURE AND FOUNDATION, THIS GROUPING INCLUDES 32-36 MT. AUBURN ST., 51-53 MT. AUBURN ST., 62-64 MT. AUBURN ST., 70-72 MT. AUBURN ST., 67-73 MT. AUBURN ST., 82 MT. AUBURN ST., 74-76 MT. AUBURN ST., 52 BRATTLE ST., 54 BRATTLE ST. SEE MAJOR ISSUES DISCUSSION.	A NUMBER OF STRUCTURES AFFECTED BY THE CONSTRUCTION. TWO CATEGORIES OF STRUCTURES HAVE BEEN IDENTIFIED: (1) MAJOR STRUCTURES REQUIRING UNDERPINNING, THIS GROUPING INCLUDES ST. PAUL'S CHURCH, LAMPOON BUILDING, QUINCY HOUSE DORM, 25 MT. AUBURN ST., THE GARAGE, ABBOT BUILDING, 1039 MASS. AVE., HARVARD COOP AND ANNEX, HOLYOKE CENTER, AND 2 MT. AUBURN ST.; (2) MINOR STRUCTURES WHERE UNDERPINNING IS QUESTIONABLE DUE TO THE TYPE OF STRUCTURE AND FOUNDATION, THIS GROUPING INCLUDES CHRIST CHURCH AND RECTORY, 32-36 MT. AUBURN ST., 62-64 MT. AUBURN ST., 70-72 MT. AUBURN ST., 74-76 MT. AUBURN ST., 51-53 MT. AUBURN ST., AND 67-73 MT. AUBURN ST.
8. HISTORIC SITES	TUNNELS CROSS UNDER FAY HOUSE AND BYERLY HOUSE BOTH ARE WITHIN CAMBRIDGE COMMON HISTORICAL DISTRICT--A NATIONAL REGISTER SITE. IT IS PROPOSED TO UNDERPIN THESE STRUCTURES. SEE MAJOR ISSUES DISCUSSION.	LAND TAKEN FROM HARVARD YARD IS WITHIN THE OLD HARVARD YARD HISTORIC DISTRICT-NATIONAL REGISTER OF HISTORIC SITE. THE BRICK WALL IN FRONT OF LEHMAN HALL WILL BE TORN DOWN. THE WALL AND PROPERTY TO BE RESTORED TO EXISTING CONDITION. SEE MAJOR ISSUES DISCUSSION.	TUNNEL CROSSES UNDER FAY HOUSE, BYERLY HOUSE, BOTH WITHIN THE CAMBRIDGE COMMON HISTORICAL DISTRICT. ALSO ADJACENT TO SEVERAL STRUCTURES OF LOCAL HISTORICAL SIGNIFICANCE: ST. PAUL'S CHURCH, LAMPOON BUILDING, LONGFELLOW HALL AND NATIONAL REGISTER SITES: WILLIAM BRATTLE HOUSE AND BRATTLE HALL. SEE MAJOR ISSUES DISCUSSION.	TUNNEL CROSSES UNDER CHRIST CHURCH, OLD BURYING GROUND, BOTH WITHIN THE CAMBRIDGE COMMON HISTORICAL DISTRICT. ALSO ADJACENT TO SEVERAL STRUCTURES OF LOCAL HISTORICAL SIGNIFICANCE: ST. PAUL'S CHURCH, LAMPOON BUILDING, AND 26 CHURCH STREET. SEE MAJOR ISSUES DISCUSSION.
9. RECREATION AREAS	TUNNEL PASSES UNDER THE CAMBRIDGE COMMON. NO SURFACE IMPACT IS ANTICIPATED.	FLAGSTAFF PARK INDIRECTLY AFFECTED BY D-1 ALTERNATE. PROBABLY NEEDED FOR ANCILLARY CONSTRUCTION SPACE. D-2 ALTERNATE INVOLVES CONSTRUCTION IN PARK AREA. PARK CAN BE RESTORED TO PRESENT OR BETTER CONDITION IN EITHER CASE.	TUNNEL PASSES UNDER CAMBRIDGE COMMON AND ADJACENT WINTHROP SQUARE. NO SURFACE IMPACT IS ANTICIPATED.	SAME AS G-1
10. ECOLOGY	NO ECOLOGICAL IMPACT ANTICIPATED. TUNNEL STRUCTURE LOCATED WITHIN CLAY, SAND AND CLAY AND TILL STRATAS, AND BELOW A PERCHED WATER TABLE.	NO ECOLOGICAL IMPACT ANTICIPATED. IT IS OUR UNDERSTANDING THAT TREES IN HARVARD YARD WERE AFFECTED BY DEWATERING FOR THE CONSTRUCTION OF THE EXISTING SUBWAY. DEWATERING FOR PROPOSED CONSTRUCTION WILL BE CLOSELY MONITORED TO MAINTAIN SAFE LEVELS FOR PLANT LIFE IN HARVARD YARD.	SAME AS A	SAME AS A
11. UTILITY SERVICE	THE FOLLOWING UTILITIES ARE TO BE RELOCATED: (1) MT. AUBURN STREET AREA - 12 IN. AND 6 IN. WATERLINE, 8 IN. GAS LINE, 36 IN. MDC SEWER, 19 IN. X 20 IN. COMBINED SEWER, 30 IN. STORM DRAIN, 10 IN. SANITARY SEWER, ELECTRIC DUCTS. (2) MASSACHUSETTS AVENUE - 20 IN. X 24 IN. COMBINED SEWER, 8 IN. WATERLINE AND ELECTRIC DUCTS.	THE FOLLOWING UTILITIES WILL BE RELOCATED: 8 IN., 20 IN., 24 IN. AND 30 IN. WATERLINES, 4 IN., 12 IN. AND 24 IN. GAS LINE, 12 INC. SEWER AND ELECTRIC DUCTS.	THE FOLLOWING UTILITIES ARE TO BE RELOCATED: (1) PUTNAM SQUARE AREA: 24 IN., 12 IN., AND 10 IN. WATERLINES, 8 IN. AND 12 IN. GAS LINES, 15 IN. AND 14 IN. BY 15 IN. SEWER. ELECTRICAL AND TELEPHONE DUCTS; (2) BRATTLE STREET (SQUARE) AREA: 10 IN. WATERLINE, 8 IN. GAS LINE, 10 IN. AND 12 IN. BY 16 IN. SEWER, ELECTRICAL AND TELEPHONE DUCTS.	THE FOLLOWING UTILITIES ARE TO BE RELOCATED IN THE PUTNAM SQUARE AREA: 24 IN., 12 IN. AND 10 IN. WATERLINES, 8 IN. AND 12 IN. GAS LINES, 15 IN. AND 14 IN. X 15 IN. SEWER, ELECTRICAL AND TELEPHONE DUCTS.

EXHIBIT M-2

HARVARD SQUARE AREA ALTERNATIVES
SUMMARY OF IMPACTS

Massachusetts Bay Transportation Authority

SHORT TERM (CONSTRUCTION)	LINE A	LINE D-1 (D-2) PROJECT	LINE G-1	LINE G-2
B. CONSTRUCTION METHODS				
1. CUT-AND-COVER	CUT-AND-COVER WORK WILL BE DONE IN 3 AREAS: (1) MT. AUBURN ST. FROM BRATTLE SQ. TO STORY ST.; (2) NORTH SIDE OF MASS. AVE. BETWEEN LINDEN ST. AND HOLYOKE ST.	CUT-AND-COVER TUNNEL ALONG MASSACHUSETTS AVE. AND PEABODY ST. FROM HOLYOKE ST. TO COMMON AND ALSO AREAS AROUND HARVARD SQ. BETWEEN HARVARD COOP AND LEHMAN HALL. D-2 FLAGSTAFF PARK AREA.	CUT-AND-COVER TUNNEL IN TWO AREAS: (1) FROM PUTNAM SQ. TO MIDWAY BETWEEN ATHENS AND BANKS STREETS ON MT. AUBURN ST., (2) BRATTLE STREET FROM BRATTLE SQUARE TO STORY STREET ALONG BRATTLE STREET.	CUT-AND-COVER TUNNEL FROM PUTNAM SQUARE TO MIDWAY BETWEEN ATHENS AND BANKS STREETS ON MT. AUBURN ST.
2. TUNNELING	DEEP-BORE WILL EXTEND FROM STORY ST. TO PORTER SQ. ACCESS SHAFT AT STORY ST. AND MT. AUBURN ST.	DEEP-BORE TUNNEL FROM THE COMMON AT HEMENWAY GYM TO PORTER SQ. STATION. CONSTRUCTION ACCESS SHAFT LOCATED AT THE PORTER SQ. STATION.	DEEP-BORE TUNNEL FROM ATHENS-BANKS STREET ALONG MT. AUBURN ST. TO BRATTLE SQUARE WITH AN ACCESS SHAFT AT ATHENS-BANKS ST. AND FROM STORY ST. ON BRATTLE ST. TO PORTER SQ. STATION. CONSTRUCTION ACCESS SHAFT LOCATED AT THE PORTER SQ. STATION.	DEEP-BORE TUNNEL FROM ATHENS-BANKS STREET TO PORTER SQUARE STATION. ACCESS CONSTRUCTION SHAFTS LOCATED AT ATHENS AND BANKS ST., CHURCH ST. GARAGE, AND PORTER SQUARE STATION.
3. LENGTH OF CONSTRUCTION	RAPID TRANSIT TUNNELS--22 MONTHS ASSUMING CONCURRENT WORK IN VARIOUS AREAS. STATION REVISIONS--8 MONTHS. NO BUSWAY WORK IS REQUIRED.	RAPID TRANSIT TUNNELS - 20 MONTHS ASSUMING CONCURRENT WORK IN VARIOUS AREAS. NEW STATION - 20 MONTHS. REVISIONS TO BUS TUNNEL - 6 MONTHS. (D-2) RAPID TRANSIT TUNNELS - 28 MONTHS; NEW STATION - 28 MONTHS; NEW BUS TUNNEL - 12 MONTHS.	RAPID TRANSIT TUNNELS - 24 MONTHS ASSUMING CONCURRENT WORK IN VARIOUS AREAS. NEW STATION - 18 MONTHS. MINOR REVISIONS TO BUS TUNNEL - 3 MONTHS.	RAPID TRANSIT TUNNELS - 24 MONTHS ASSUMING CONCURRENT WORK IN VARIOUS AREAS. NEW STATION - 18 MONTHS. MINOR REVISIONS TO BUS TUNNEL - 3 MONTHS.
4. CONSTRUCTION DIFFICULTY	NOT AS DIFFICULT AS LINE G-1; MORE DIFFICULT THAN D-1 OR D-2. DIFFICULTY CREATED BY TUNNELING UNDER BUILDINGS.	LEAST DIFFICULT TO CONSTRUCT BECAUSE OF PREDOMINANCE OF CUT-AND-COVER WORK.	NOT AS DIFFICULT AS LINE G-2; MORE DIFFICULT THAN LINE A. TUNNEL UNDER AND ADJACENT BUILDINGS, TUNNEL PROFILE PARTLY IN ROCK, PARTLY IN SOIL PRODUCING AN UNDESIRABLE MIXED-FACE TUNNELING SITUATION.	THE MOST DIFFICULT TO CONSTRUCT. TUNNELING UNDER AND ADJACENT BUILDINGS: TUNNEL PROFILE PARTLY IN ROCK, PARTLY IN SOIL PRODUCING AN UNDESIRABLE MIXED-FACE TUNNELING SITUATION; LARGE DIAMETER TUNNELING SHIELD REQUIRED FOR STATION TUNNELS.
PROJECT COSTS				
A. TOTAL CONSTRUCTION COSTS	$44,000,000	D-1 $32,000,000 D-2 $35,000,000	$74,000,000	$79,000,000
B. OPERATION COSTS DURING CONSTRUCTION	$89,000	$121,000	$34,000	$34,000
C. INCREMENTAL OPERATIONS COSTS PER YEAR	$146,000	$163,000	$136,000	$139,000
CONTRACTURAL REQUIREMENTS				
A. BUS TUNNEL CONNECTING MASS. AVENUE AND MT. AUBURN ST.	EXISTING BUS TUNNEL REMAINS.	EXISTING BUS TUNNEL REMAINS.	EXISTING BUS TUNNEL REMAINS.	EXISTING BUS TUNNEL REMAINS.
B. MAINTAIN PRESENT LEVEL OF TRANSIT SERVICE DURING CONSTRUCTION	SERVICE MAINTAINED WITH MINOR INTERFERENCE.	SERVICE MAINTAINED TO A DEGREE. SOME BUS LINES TO BE REROUTED TO OTHER TRANSIT STATIONS. TEMPORARY TRANSIT STATION WILL CAUSE SOME INCONVENIENCE TO PASSENGERS. BUS STOPS ON MASSACHUSETTS AVE. NEAR HARVARD YARD ELIMINATED.	SERVICE MAINTAINED WITH MINOR INTERFERENCE.	SERVICE MAINTAINED WITH MINOR INTERFERENCE.
C. PROVIDE ACCESS FROM BRATTLE SQUARE TO STATION	NO ACCESS FROM BRATTLE SQUARE.	CAN BE PROVIDED IN ABANDONED EXISTING TUNNEL.	STATION ENTRANCE IN BRATTLE SQUARE.	CAN BE PROVIDED IN ABANDONED EXISTING TUNNEL.
D. AVOID SEVERE SURFACE DISRUPTION DURING CONSTRUCTION	DISRUPTION MINIMIZED THROUGH USE OF TRAFFIC REROUTINGS, DECKING-OVER OF EXCAVATIONS, PARKING RESTRICTIONS.	SAME AS A	SAME AS A	SAME AS A
E. TURNBACK & STORAGE FACILITIES	EXISTING FACILITIES MAINTAINED.	ABANDONED TUNNEL COULD BE USED.	PORTIONS OF ABANDONED TUNNEL COULD BE USED.	PORTIONS OF ABANDONED TUNNEL COULD BE USED.

EXHIBIT M-3

HARVARD SQUARE
AREA ALTERNATIVES
SUMMARY OF IMPACTS

UNITED STATES GOVERNMENT

Memorandum

DEPARTMENT OF TRANSPORTATION

URBAN MASS TRANSPORTATION ADMINISTRATION

DATE:

In reply refer to:

APR 21 1977

SUBJECT: On-site Inspection of Harvard Square, Boston, Massachusetts, 13 April 1977

FROM : Environmental Program Specialist

TO : File

On April 13, 1977, an on-site inspection of Harvard Square and consultation was held per a request by the Advisory Council on Historic Preservation (ACHP) in accordance with §800.5(b) of their procedures. In attendence were Sharon Conway(ACHP), Elizabeth Amadon and Margo Webber(Massachusetts Historical Commission), Jack Leary, Charles Steward, Mel Naseck, and Donna Garofano(MBTA), Charles Sullivan, Allison Crump, Robert Neily and Charles Elliot(Cambridge Historical Commission), Supratik Bowes (Harvard University), Peter Hopkinson and Ted Tsoi (Skidmore, Owings and Merrill), Jerry Angell(DeLeuw Cather), Dominic D'eramo(Sverdrup and Parcel) and Peter Benjamin, Joe Clougherty, Kiyoshi Mano and myself(UMTA).

We gathered at 10:00 a.m. at the Kiosk in Harvard Square to inspect the site of the proposed Red Line project and the effect it will have on National Register properties. We examined the Kiosk, Flagstaff Park, and Old Harvard Yard especially the Johnston Gate, all within the Cambridge Common Historic District. Peter Hopkinson, the architect with SOM, conducted the inspection. He discussed alternative station entrance plans, landscaping, restoration of existing sites and probable construction impacts and mitigation. Later we met at SOM to discuss the alternatives and proposals for inclusion in the Memorandum of Agreement to mitigate the adverse effects.

The Kiosk will be dismantled, stored and reused. A number of options exist including use as a newstand or as a shelter for the escalators leading into the station. The exact location is undetermined as yet but it will be placed near its current site. The CHC and SHPO will review all final plans. Johnston's Gate will not be disturbed but part of the wall will be removed temporarily for slurry walls and will be restored to its original form when construction is completed.

EXHIBIT N

A new proposal for Flagstaff Park was raised by Charles Sullivan of the CHC. This involves removing a wall constructed in 1909 from the National Register property. The SHPO's office concurs with this proposal but since this is a new design the Advisory Council must review it. Sharon indicated it would take about 2 weeks for them to decide if removal of the wall and/or moving the location of a statue would be satisfactory. Mr. Sullivan indicated the wall was a visual intrusion on the historic original Cambridge Common. UMTA requested that this issue be resolved and the decision incorporated into the Memorandum of Agreement. All parties are amenable to an Agreement which uses the draft prepared by the MBTA as a basis with the addition of some data for noise and vibration suppression which is contained in the preliminary case report. The MBTA will provide us with 2 options for inclusion in the Agreement. Option A will temporarily remove the wall in Flagstaff Park and replace it after construction, option B will remove it permanently. The agreement will only be concerned with National Register properties in Harvard Square.

The Arlington Town Center District, also a National Register property, is not adjacent to nor abutting the station entrance. We feel a determination of "no effect" can be made with concurrence by the SHPO. We requested a survey be conducted, if needed, to locate any properties which may be eligible for nomination to the Register. The CHC and the SHPO feel that a thorough survey has been conducted in Cambridge and no additional eligible properties should surface. While the alignment from Cambridge to Arlington has been surveyed,a thorough review of the properties should be conducted to prevent last minute nominations. The MBTA & SHPO plan to meet with the Arlington Historical Commission to discuss historic properties and effects.

The MBTA will be revising the proposals for the Agreement. The Advisory Council will be making a decision about removing the wall in Flagstaff park in approximately two weeks. They will advise us of the decision to be incorporated into the Agreement. The final design of the Kiosk and Flagstaff Park

will remain open with a condition included for reviews and approval by the SHPO and CHC. The MBTA will send us their proposals which we will forward to the Advisory Council for inclusion in the Agreement which they will prepare (per §800.5(g) of their Procedures).

Sue Kaminsky

Sue Kaminsky

Attachments:

MBTA Draft of Agreement
CHC Review

The Commonwealth of Massachusetts
Office of the Secretary
Massachusetts Historical Commission
294 Washington Street Boston, Massachusetts 02108
(617) 727-8470

COPY

Secretary of the Commonwealth

May 17, 1977

Mr. Peter Benjamin
Director, Office of Program Analysis
Urban Mass Transportation Administration
400 7th Street, SW
Washington, D.C. 20590

Re: Red Line Extension
Cambridge and Arlington, Massachusetts

Dear Mr. Benjamin:

As a follow-up to our April 13, 1977 meeting with representatives of your office, the Advisory Council on Historic Preservation, and the project proponents, and after further consultation with the Cambridge Historical Commission and the Arlington Historical Commission as agreed upon at that time, we have the following comments.

After careful review of the proposed project, I, as State Historic Preservation Officer in Massachusetts, feel that the Cambridge portion of the project will have no adverse effect on any above-ground properties listed or eligible for the National Register of Historic Places. To insure that there will not be adversity, the Massachusetts Historical Commission and the Cambridge Historical Commission must be provided further review of the Harvard Square portion, including location and preservation of the Harvard Square Kiosk, design of the square, above-ground subway and news stand structures, signage and street furniture, and design/redesign of Flagstaff Park.

For the Arlington section of the project, we feel that there will be no effect on historic properties listed or eligible for the National Register. Since the subway entrance at Arlington Center is adjacent to the Arlington Town Center National Register District, both the Massachusetts Historical Commission and the Arlington Historical Commission request review of the subway entrance at this location.

EXHIBIT O

May 17, 1977
Mr. Peter Benjamin

As discussed in our April 13 meeting, the Memorandum of Agreement for this project should include the issues outlined in the Draft Memorandum prepared by the MBTA in consultation with the MHC (see attached).

These comments do not pertain to archeological resources, which will have to be considered separately at a later date. Please contact us if we can be of further assistance as UMTA carries out its responsibilities under 36 CFR 800.

Sincerely yours,

Elizabeth Reed Amadon

Elizabeth Reed Amadon
Executive Director
Massachusetts Historical Commission
State Historic Preservation Officer

xc: Sue Kaminsky, UMTA
Charles Steward, MBTA

ERA/MBW/etd

APPENDIX H

SUPPORTING DATA ON AIR QUALITY

SUPPORTING DATA
FOR THE
AIR QUALITY SECTION
OF THE
ENVIRONMENTAL ANALYSIS REPORT
RED LINE EXTENSION
HARVARD SQUARE TO ARLINGTON HEIGHTS

APRIL 1976

DE LEUW, CATHER & COMPANY
Engineers and Planners
Boston, Massachusetts

TABLE OF CONTENTS

I. INTRODUCTION

The air quality impact resulting from the proposed project is determined by the following factors:

- o Regional meteorological and micrometeorological characteristics
- o Areawide air pollutant emissions and their time variations
- o Vehicle mile travel (VMT) and its spatial distribution.

The factors not only govern pollution levels on a regional scale, but also dictate pollution levels at local problem areas such as station areas and the vicinity of specific facilities.

To fully disclose the effects of the proposed project on air quality, two major tasks were undertaken--mesoscale and microscale air quality analysis.

The mesoscale analysis includes an examination of meteorological characteristics on a regional basis; an analysis of areawide pollutant emissions of total suspended particulates, sulfur dioxide, ozone, hydrocarbons and carbon monoxide; an investigation of existing air quality and a projection of air quality for the build and no-build cases.

Microscale analysis includes air quality evaluation on a station specific scale for the Harvard Square, Davis Square, Alewife, Arlington Center and Arlington Heights areas.

II. MESOSCALE ANALYSIS

A. METEOROLOGY

Physical Features of the Metropolitan Boston Air Quality Control Region

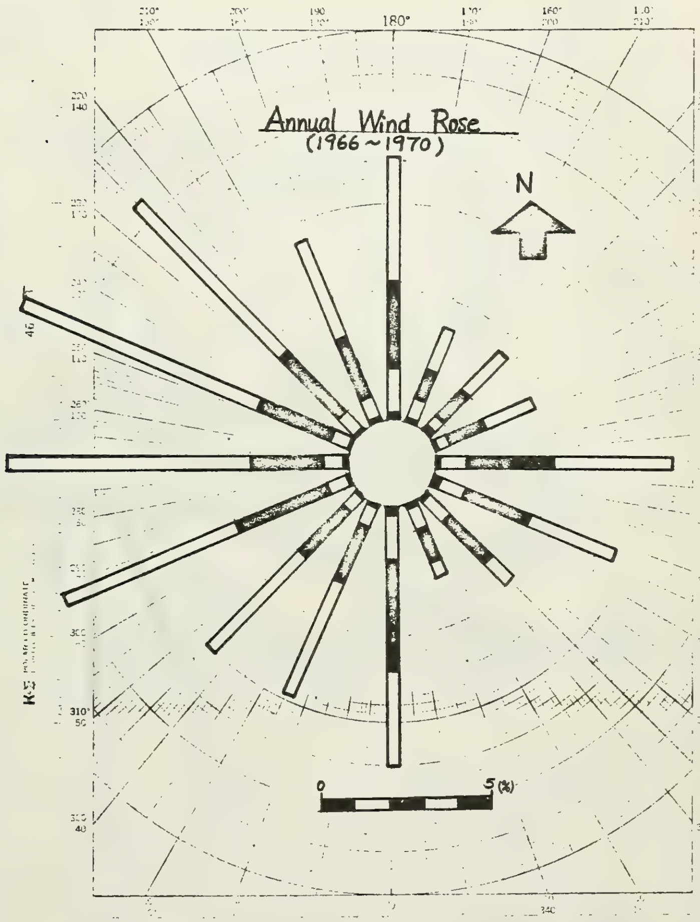
The Metropolitan Boston area is designated by the Bureau of Air Quality Control of the Commonwealth of Massachusetts as Air Quality Control Region 119 (AQCR 119) and designated by the U.S. EPA as Air Quality Control Region I. The region lies in a flat coastal basin encircled by low hills to the south, west and north, and by Massachusetts Bay on the east. Elevations range from zero to 600 feet above sea level and average 100 feet above sea level. These topographical features, while not of major consequence, are of significance in confining the ventilation of the occasional sea breezes. Boston's east coast location greatly influences local climatology and meteorology.

Meteorology

Local climatological data are principally collected at Logan International Airport. The statistics of the climatological data indicate that the region is subject to a coastal temperature climate with a normal annual temperature of 51.4^{o}F, a normal annual precipitation of 43 inches and 5600 annual heating degree days.

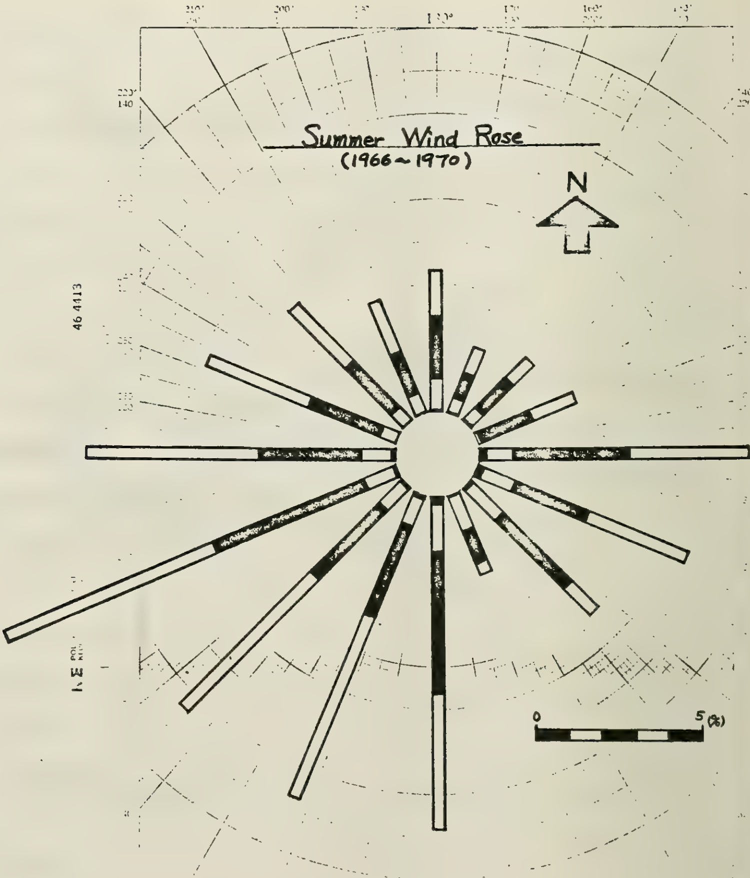
The frequency of occurrence of a given wind speed class and direction is depicted by the annual wind rose, which was constructed by dividing wind speed into four classes, namely 0-3, 3.1-6, 6.1-10 knots and larger than 10 knots with the lowest class shown on the inside of the rose (Figure 1).

Figure 1



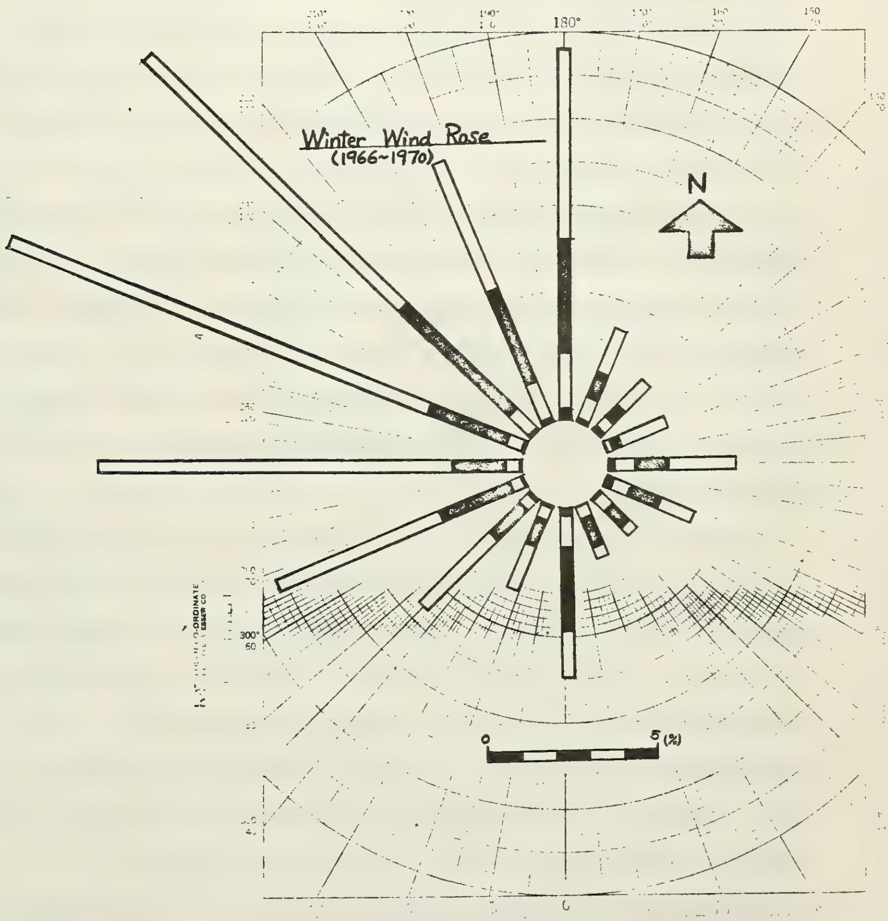
Logan International Airport, Mass.

Figure 2



Logan International Airport, Mass

Figure 3



Logan International Airport, Mass

The same procedure was used to summarize 5 year (1966-1970) data in summer and winter wind roses as shown in Figures 2 and 3.

The three lowest classes of wind speed in the annual wind rose indicate rather uniform occurrence across the compass. However, in the highest class (larger than 10 knots) of wind speed, winds out of the northwest, west and southwest are highly favored.

The summer wind rose depicts prevailing wind from the southwest sector with wind speeds between 10 and 15 knots. On the contrary, northwesterly winds with wind speeds between 10 and 15 knots dominate in the winter wind rose. The seasonal winds in spring and fall are quite transitional, hence their resultant wind directions and speeds are rather unpredictable.

The average seasonal morning mixing depth in the region ranges from 475 to 800 meters with the lowest ceiling generally occurring in summer. The seasonal afternoon mixing height is rather uniform through the year and ranges from 1000 to 1200 meters with an annual average of 1100 meters. The wind speeds vary from 17.1 knots in spring afternoons to 10.7 knots in summer mornings with annual averages of 13.6 knots for mornings and 15.5 knots for afternoons.[1,2]

[1] GCA Corporation, Transportation Controls to Reduce Motor Vehicle Emissions in Boston, Massachusetts, U.S. EPA, Office of Air and Water Programs, Research Triangle Park, N.C., December, 1972.

[2] G.C. Holzworth, Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States, U.S. EPA, Office of Air Programs, Research Triangle Park, N.C., January, 1972.

The radiosonde data (1200 GMT) taken at Chatham, Massachusetts, and ground observations at Logan International Airport were analyzed for 48 days in 1973 and the first half of 1974 during which carbon monoxide levels were particularly high as recorded by at least two of the four air quality sampling stations around the study area. The coincidence of minimum mixing heights with dawning hours suggests that ground radiational isotherm or inversion is the major cause for occasional limited ventilation in the air shed of the metropolitan Boston region. Maximum mixing height in the early afternoon is due to the maximum erosion of the radiational ground inversion by solar insolation and due to the maximum degree of mechanical turbulence induced by wind.

A total number of approximately 10 forecast days of high meteorological potential for air pollution is concluded from an analysis of 5 year meteorological data for the Boston Region.[2] However, stable or stagnant weather conditions persisting more than 3 days occur quite infrequently, about once a year.[2]

The worst meteorological conditions for a potential air pollution episode in the region indicated by 5 year meteorological data and radiosonde measurements are low wind speed (1 m/sec) Pasquill stability class "D" and a mixing height of 100 meters. The annual joint probability of occurrence of Pasquill class "D" stability and low wind speed is 0.00123 which is equivalent to 10.8 hours in an entire year. If the mixing height of 100 meters is taken into consideration, the joint probability of occurrence is insignificant.

The most probable meteorological conditions are Pasquill class "E" stability, wind speed of 14 mph and average mixing height of 1000 meters.

B. AREAWIDE AIR POLLUTANT EMISSION ANALYSIS

In the Air Quality Control Region, both stationary and mobile sources are major sources for pollutant emissions. However, vehicular emissions contribute more than 95%[1,2] of the total regional emissions as far as the carbon monoxide (CO) is concerned, and will continue to remain so from now until the target year of the proposed project. Therefore, total CO emissions will continue to be a function of daily vehicle mile travel (VMT) in the region.

Concentration of CO--a relatively inert gas--is reduced primarily by atmospheric dispersion process. The local CO level is determined by the local CO sources, their emission strength and wind speed. Based on VMT projection and normal growth of non-vehicular sources, the total CO emissions at Kenmore Square were estimated as shown in Table 1 by the BTCP study for 1976, 1977, 1978, 1981, and 1984. Assuming unique ratio[1] between emission intensity (kg/day/mi^2), and CO concentration for a locality having uniform emission activity (or traffic activity), CO levels at Kenmore Square were calculated from the projected emissions as shown in Table 1.

The CO emission as well as its concentration will continue to decrease with time due to the ongoing Federal Motor Vehicle Pollution Control Program (FMVPCP). However, the

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[1] GCA Corporation, Transportation Controls to Reduce Motor Vehicle Emissions in Boston, Massachusetts, U.S. EPA, Office of Air and Water Programs, Research Triangle Park, N.C., November, 1972. (BTCP)

[2] 1972 National Emissions Report, National Emission Data System (NEDS) of the Aerometric and Emissions Reporting System (AEROS), U.S. EPA, Office of Air and Waste Management, Research Triangle Park, N.C., June, 1974.

Table 1

CO Emission (kg/day) and Concentration (ppm)*

Kenmore Square, Boston
(Area = 0.471 sq. mi.)

	1974		1976		1977		1978		1981		1984	
With Transportation Control Strategies ?	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
Vehicular Emissions	11419	11243	9064	7299	7164	3790	5917	3355	3468	2583	2339	1930
Non-vehicular Emissions	50	50	53	53	54	54	56	56	63	63	70	70
Total Emissions	11469	11293	9117	7352	7218	3844	5973	3411	3531	2646	2409	2000
CO Levels (8 hour avg.)	19.5	19.2	15.5	12.5	12.3	6.5	10.1	5.8	6.0	4.5	4.1	3.4

* Ref. GCA Corporation, Transportation Controls to Reduce Motor Vehicle Emissions in Boston, Massachusetts, U.S. EPA, Office of Air and Water Programs, Research Triangle Park, N.C., November, 1972.

decrease of CO levels without transportation controls will not be sufficient to meet the air quality standards by the 1977 deadline. The effects of the transportation controls are also shown in Table 1.

The study area of the proposed project is within five municipalities--Arlington, Belmont, Cambridge, Lexington and Somerville. After examination of previous traffic studies and vehicle registration records, each municipality was found to have different traffic demand and growth patterns. Based on the VMT growth arrived at from traffic studies, vehicle emission factors, model year distribution of vehicles, mixture of light- and heavy-duty vehicles, average traffic speed and VMTs on primary traffic links and on secondary traffic roads, the total vehicular emissions of CO, hydrocarbons (HC) and nitrogen oxides (NO_x) for each municipality are shown in Tables 2a, 2b, and 2c respectively. Heavy-duty vehicles are assumed to constitute 10% of the vehicle mix.

Considering CO alone and assuming uniform vehicular emissions throughout each municipality, the vehicular emission intensity for 1974 was calculated by dividing the emission with the total of each municipality. The order of decreasing vehicular emission intensity, as shown in Table 2, is Cambridge, Arlington, Somerville, Belmont and Lexington. The ranking also indicates the decreasing order of average traffic activity within each municipality with Cambridge ranked first and Lexington last. It has to be noted that this treatment does not preclude any possible problem areas in Lexington having the least traffic.

Table 2a. Emissions from Mobile Sources by Township (kg/day) in Metropolitan Boston, NW

Pollutant: Carbon Monoxide

CITY OR TOWN	AREA (Sq.Mi.)	DAILY TOTAL EMISSIONS			DAILY EMISSION INTENSITY (/Sq.Mi)		
		1974	1980 No-Build	1980 Build	1974	1980 No-Build	1980 Build
Arlington	5.165	27,770	14,624	14,288	5,377	2,831	2,766
Belmont	4.878	17,900	9,671	9,429	3,670	1,983	1,933
Cambridge	7.174	72,860	37,071	35,811	10,156	5,167	4,992
Lexington	15.496	36,210	20,263	20,020	2,337	1,308	1,292
Somerville	5.022	24,370	10,491	10,344	4,853	2,089	2,060

Table 26. Emissions from Mobile Sources by Township (kg/day) in Metropolitan Boston, NW

Pollutant: Nitrogen Oxides

CITY OR TOWN	AREA (Sq.Mi.)	DAILY TOTAL EMISSIONS			DAILY EMISSION INTENSITY (/Sq.Mi)		
		1974	1980 No-Build	1980 Build	1974	1980 No-Build	1980 Build
Arlington	5.165	3,400	1,839	1,797	658	356	348
Belmont	4.878	2,420	1,308	1,275	496	268	261
Cambridge	7.174	5,020	1,261	1,218	700	176	170
Lexington	15.496	5,960	3,429	3,388	385	221	219
Somerville	5.022	2,930	1,815	1,790	583	361	356

Table 2c. Emissions from Mobile Sources by Township (kg/day) in Metropolitan Boston, NW

Pollutant: Total Hydrocarbons

CITY OR TOWN	AREA (Sq.Mi.)	DAILY TOTAL EMISSIONS			DAILY EMISSION INTENSITY (/Sq.Mi)		
		1974	1980 No-Build	1980 Build	1974	1980 No-Build	1980 Build
Arlington	5.165	4,080	1,632	1,594	790	316	309
Belmont	4.878	2,780	1,281	1,249	570	263	256
Cambridge	7.174	9,010	4,086	3,947	1,256	570	550
Lexington	15.496	5,850	2,900	2,865	376	187	185
Somerville	5.022	3,790	1,678	1,655	755	334	330

Hydrocarbons and nitrogen oxides are well known as ingredients of photochemical reactions which lead to production of harmful photochemical oxidants or smog. The relatively long time lag between the release of hydrocarbons and nitrogen oxides and the formation of photochemical oxidants is the main reason for these reactions being a regional phenomena. Therefore, emissions of hydrocarbons and nitrogen oxides can only be handled meaningfully on a region-wide basis. According to source inventory studies[2,3], transportation contributes about 70% of the total hydrocarbon emissions and approximately 50% of the total nitrogen oxides emissions in the metropolitan Boston AQCR (air quality control region) as shown in Tables 3 and 4.

Hydrocarbon emissions and oxidant levels within the Route 128 region are based on the BTCP's[1] source inventory study. The original study gives only the 1970, 1977, 1978, and 1979 values. By using the rollback techniques, the emissions and oxidant levels are interpolated and extrapolated for 1974 and 1980 with allowance for normal growth of both stationary and mobile sources.

Because of the FMVPC program, the oxidant level declines with time despite normal growth of mobile sources. However, the decline will not be sufficient for the attainment of the national ambient air quality standards (NAAQS) in 1977 without transportation control strategies. With the implementation

[3] Walden Research Corporation, Summary Report: Air Pollutant Emission Inventory for the Metropolitan Boston Air Pollution Control District (30 Municipalities). prepared for the Bureau of Air Quality Control of the Commonwealth of Massachusetts, and the U.S. EPA, June, 1972.

Table 3

Percentage of the Total Emission Contributed by Transportation and Steam Electric Power Plants in the Metropolitan Boston Region (AQCR 119)

Source	TSP*	NO_x	CO	HC	SO_x	Reference
Transportation	15.1	53.8	99.2	78.8	1.9	Walden[3]
	15.7	40.8	95.4	69.8	1.2	NEDS[2]
Steam Electric Power Plants	10.7	26.1	<0.1	1.2	45.9	Walden[3]
	9.3	28.2	~0.15	<0.4	41.4	NEDS[2]

* total suspended particulates

~~Appendix~~ Table 4-1

AQCR 119 METROPOLITAN BOSTON (MASS)

Emission categories	Particulates	Sulfur oxides	Nitrogen oxides	Hydro-carbons	Carbon monoxide
	Pollutant, tons per year				
GRAND TOTAL	36,763	331,633	168,553	233,960	883,219
-AREA	27,655	154,254	112,964	228,919	872,439
-POINT	9,108	177,379	55,588	5,041	10,780
FUEL COMBUSTION-AREA	16,980	150,037	43,591	3,510	4,015
-POINT	7,205	175,229	55,073	1,261	1,854
External Combustion-area	16,980	150,037	43,591	3,510	4,015
-point	7,205	175,229	55,073	1,261	1,854
Residential Fuel-area	4,551	17,096	5,918	1,452	3,689
Anthracite Coal	109	275	33	27	981
Bituminous Coal	63	179	9	63	282
Distillate Oil	3,903	16,627	4,684	1,171	1,952
Residual Oil	0	0	0	0	0
Natural Gas	449	14	1,181	189	472
Wood	27	1	11	2	2
Electric Generation-point	3,421	137,176	47,617	894	1,360
Anthracite Coal	0	0	0	0	0
Bituminous Coal	0	0	0	0	0
Lignite	0	0	0	0	0
Residual Oil	3,403	137,175	46,875	893	1,339
Distillate Oil	0	0	0	0	0
Natural Gas	19	1	742	1	21
Process Gas	0	0	0	0	0
Coke	0	0	0	0	0
Solid Waste/Coal	0	0	0	0	0
Other	0	0	0	0	0
Industrial Fuel-area	796	1,747	1,585	224	13
-point	2,745	25,428	4,996	245	326
Anthracite Coal-area	0	0	0	0	0
-point	0	0	0	0	0
Bituminous Coal-area	517	252	66	4	9
-point	991	432	131	2	7
Lignite-point	0	0	0	0	0
Residual Oil-area	73	1,143	190	9	1
-point	1,737	24,991	4,657	239	306
Distillate Oil-area	123	350	493	25	2
-point	2	4	7	0	0
Natural Gas-area	84	3	836	186	2
-point	16	1	201	4	12
Process Gas-area	0	0	0	0	0
-point	0	0	0	0	0
Coke-point	0	0	0	0	0
Wood-area	0	0	0	0	0
-point	0	0	0	0	0
Liquid Petroleum Gas-point	0	0	0	0	0
Bagasse-point	0	0	0	0	0
Other-point	0	0	0	0	0
Commercial-Institutional Fuel-area	11,633	131,194	36,088	1,834	312
-point	1,038	12,625	2,460	122	168
Anthracite Coal-area	0	0	0	0	0
-point	0	0	0	0	0
Bituminous Coal-area	0	0	0	0	0
-point	144	69	18	1	2
Lignite-point	0	0	0	0	0
Residual Oil-area	7,673	120,470	20,017	1,001	67
-point	882	12,548	2,325	116	155
Distillate Oil-area	3,774	10,718	13,096	755	50
-point	3	8	12	1	1
Natural Gas-area	185	6	975	78	195
-point	10	0	106	4	10
Wood-area	0	0	0	0	0
-point	0	0	0	0	0
Liquid Petroleum Gas-point	0	0	0	0	0
Miscellaneous-point	0	0	0	0	0
Internal Combustion-point	0	0	0	0	0
Electric Generation	0	0	0	0	0
Distillate Oil	0	0	0	0	0
Natural Gas	0	0	0	0	0
Diesel Fuel	0	0	0	0	0
Industrial Fuel	0	0	0	0	0
Distillate Oil	0	0	0	0	0
Natural Gas	0	0	0	0	0
Gasoline	0	0	0	0	0
Diesel Fuel	0	0	0	0	0

Emission categories	Particulates	Sulfur oxides	Nitrogen oxides	Hydro-carbons	Carbon monoxide
	Pollutant, tons per year				
Other	0	0	0	0	0
Commercial-Institutional	0	0	0	0	0
Diesel Fuel	0	0	0	0	0
Other	0	0	0	0	0
Engine-Testing	0	0	0	0	0
Aircraft	0	0	0	0	0
Other	0	0	0	0	0
Miscellaneous	0	0	0	0	0
INDUSTRIAL PROCESS-POINT	300	1,507	0	3,320	33
Chemical Manufacturing	104	1,507	0	328	0
Food/Agriculture	10	0	0	0	0
Primary Metal	0	0	0	0	0
Secondary Metals	9	0	0	0	33
Mineral Products	176	0	0	0	0
Petroleum Industry	0	0	0	0	0
Wood Products	0	0	0	0	0
Evaporation	0	0	0	2,991	0
Metal Fabrication	0	0	0	0	0
Leather Products	0	0	0	0	0
Textile Manufacturing	0	0	0	0	0
Inprocess Fuel	0	0	0	0	0
Other/Not Classified	0	0	0	0	0
SOLID WASTE DISPOSAL-AREA	4,912	390	543	9,256	25,397
-POINT	1,604	642	515	460	8,893
Government-point	1,517	627	502	376	8,777
Municipal Incineration	1,517	627	502	376	8,777
Open Burning	0	0	0	0	0
Other	0	0	0	0	0
Residential-area	2,065	34	69	6,884	20,653
On Site Incineration	2,065	34	69	6,884	20,653
Open Burning	0	0	0	0	0
Commercial-Institutional-area	275	34	46	229	459
-point	84	14	12	82	112
On Site Incineration-area	275	34	46	229	459
-point	84	14	12	82	112
Open Burning-area	0	0	0	0	0
-point	0	0	0	0	0
Apartment-point	0	0	0	0	0
Other-point	0	0	0	0	0
Industrial-area	2,571	321	428	2,142	4,285
-point	3	1	1	1	4
On Site Incineration-area	2,571	321	428	2,142	4,285
-point	3	1	1	1	4
Open Burning-area	0	0	0	0	0
-point	0	0	0	0	0
Auto Body Incineration-point	0	0	0	0	0
Other-point	0	0	0	0	0
Miscellaneous-point	0	0	0	0	0
TRANSPORTATION-AREA	5,764	3,827	68,830	163,227	843,077
Land Vehicles	4,368	2,930	67,485	149,534	834,514
Gasoline	4,199	2,520	65,528	149,148	833,214
Light Vehicles	3,912	2,347	56,075	127,800	740,717
Heavy Vehicles	278	167	9,259	20,741	89,166
Off Highway	9	5	194	608	3,331
Diesel Fuel	169	410	1,957	386	1,300
Heavy Vehicles	0	0	0	0	0
Off Highway	57	118	1,621	162	985
Rail	112	292	336	224	314
Aircraft	1,191	259	756	3,019	8,113
Military	86	16	41	199	214
Civil	82	16	74	362	2,070
Commercial	1,024	227	641	2,458	5,830
Vessels	204	639	589	294	400
Bituminous Coal	0	0	0	0	0
Diesel Fuel	143	371	428	285	400
Residual Oil	62	267	160	8	1
Gasoline	0	0	0	0	0
Gas Handling Evaporation Loss	0	0	0	10,379	0
MISCELLANEOUS-AREA	0	0	0	52,926	0
Slash Burning	0	0	0	0	0
Solvent Evaporation Loss	0	0	0	52,926	0
MISCELLANEOUS-POINT	0	0	0	0	0

of the transportation control strategies, the NAAQS would be complied with by the 1977 deadline.

In a comparison of the vehicular HC emissions in the five municipalities under study with the total emissions within the Route 128 region, the corridor area would contribute 8.9% of the total in 1984 for the no-build alternative without transportation control strategies as compared to 14% in 1974.

C. EXISTING AIR QUALITY

Four sampling stations operated by the Bureau of Air Quality Control of the Commonwealth of Massachusetts are located close to the project corridor. The types and locations of the sampling sites are described in Table 5 and relative positions indicated in Figure 4.

The existing air quality levels[1] reported by these four sampling stations are discussed in the following sections for each type of pollutant. Existing air quality is assessed by comparing data with the corresponding national and state standards (see Appendices 1 and 2).

Total Suspended Particulates (TSP)

Monthly maximum, arithematic mean and minimum levels of TSP at four sampling sites are represented graphically in Figures 5 and 6. No violations of the National Primary Ambient Air Quality Standards (NPAAQS) were observed at any stations in 1974 from the available data.

Both the Massachusetts standards (MAAQS) and National Secondary Standards (NSAAQS) were violated several times in 1974. A general characteristic of the monthly arithmetic means of TSP suggests higher TSP levels in winter.

Statistical analysis of the 1974 TSP data is presented in Figures 7 and 8. The annual geometric means of TSP determined graphically indicate that only the Wellington Circle and Science Park sampling sites conformed to the national annual air quality standard for TSP ($60 \mu g/m^3$).

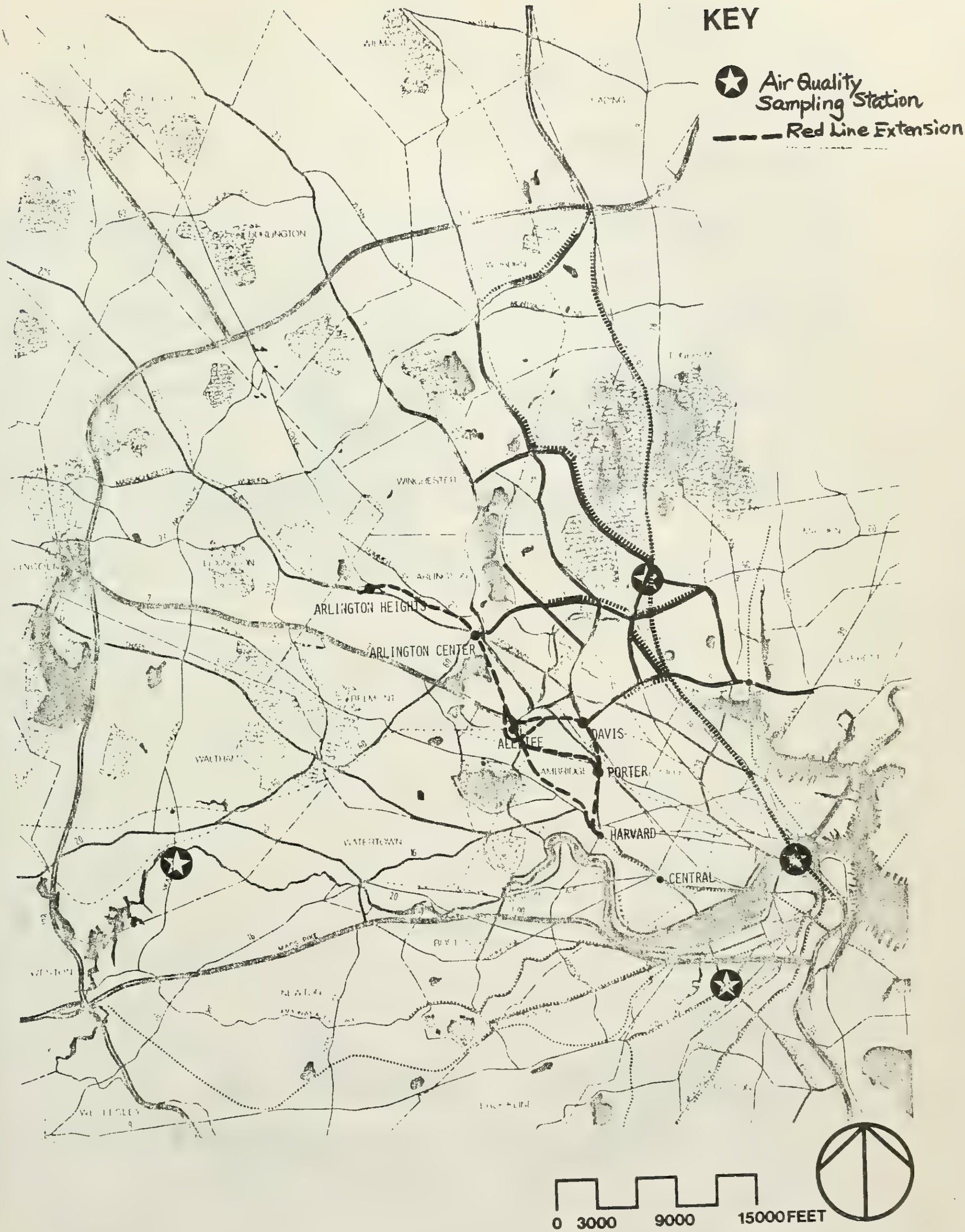
[1] Data made available from the Bureau of Air Quality Control of the Commonwealth of Massachusetts.

Table 5

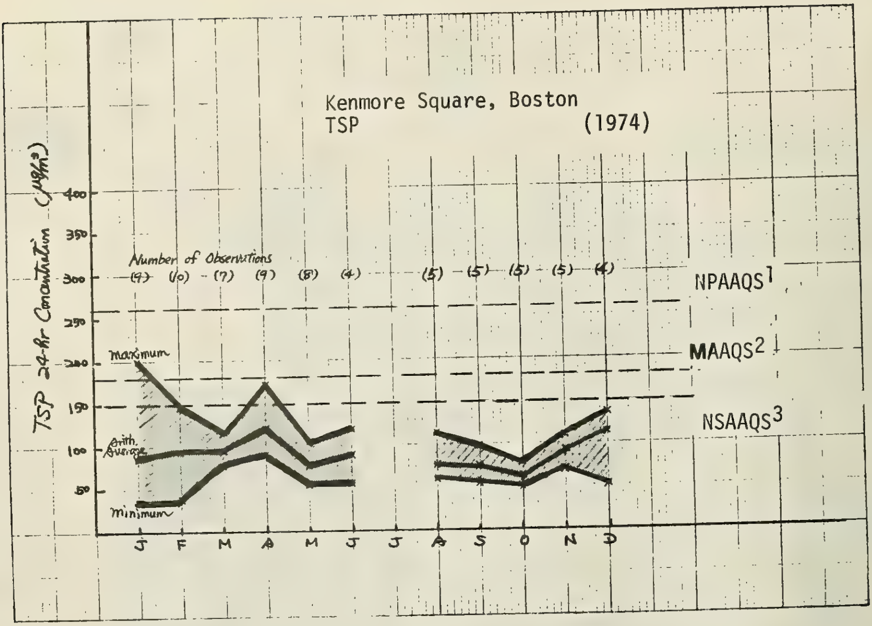
Type and Location of Air Quality Sampling Site*

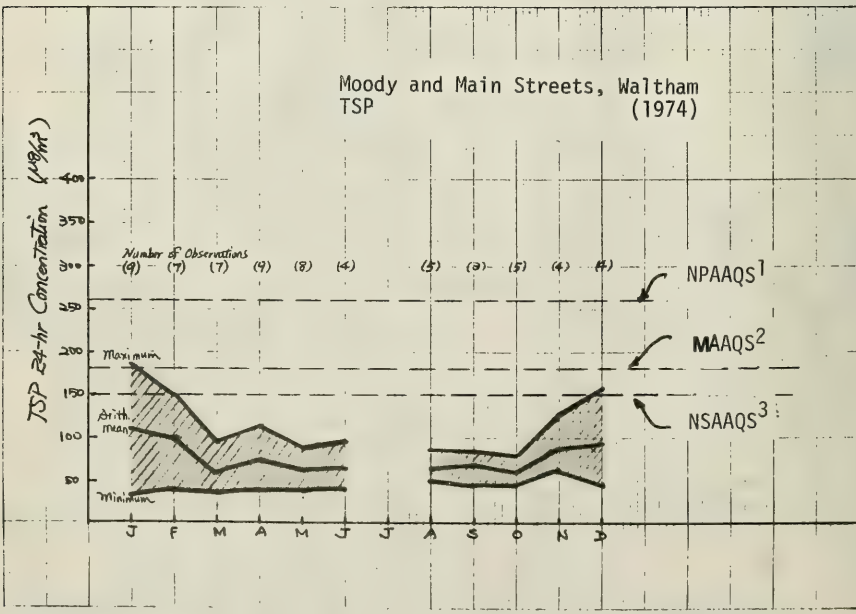
Name	Location	Site Location Type	Elevation of Sampler Above Ground Level (feet)	Population
Kenmore Square	590 Commonwealth Ave., Boston	Commercial	15	641,070
Science Park	Msgr. O'Brien Highway, Cambridge	Residential	15	100,360
Wellington Circle	The Fellsway and Route 16, Medford	Industrial	15	64,400
Moody and Main Streets	Moody and Main Streets; Waltham	Commercial	15	61,580

* data from Bureau of Air Quality Control of the Commonwealth of Massachusetts



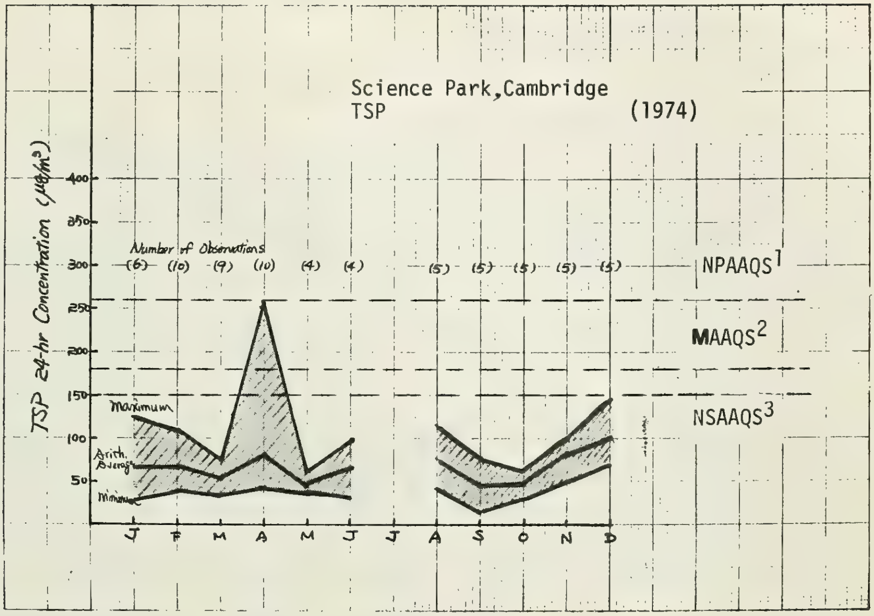
~~Exhibit~~ Figure 4 Air Quality Sampling Stations



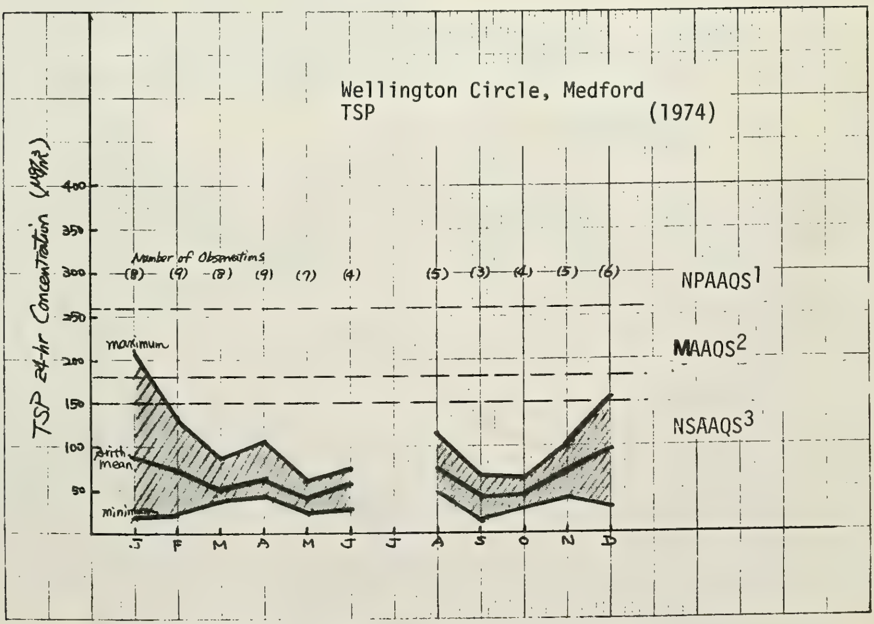


1. National Primary Ambient Air Quality Study (24-hr max.)
2. Massachusetts AAQS (24-hr max.)
3. National Secondary AAQS (24-hr max.)

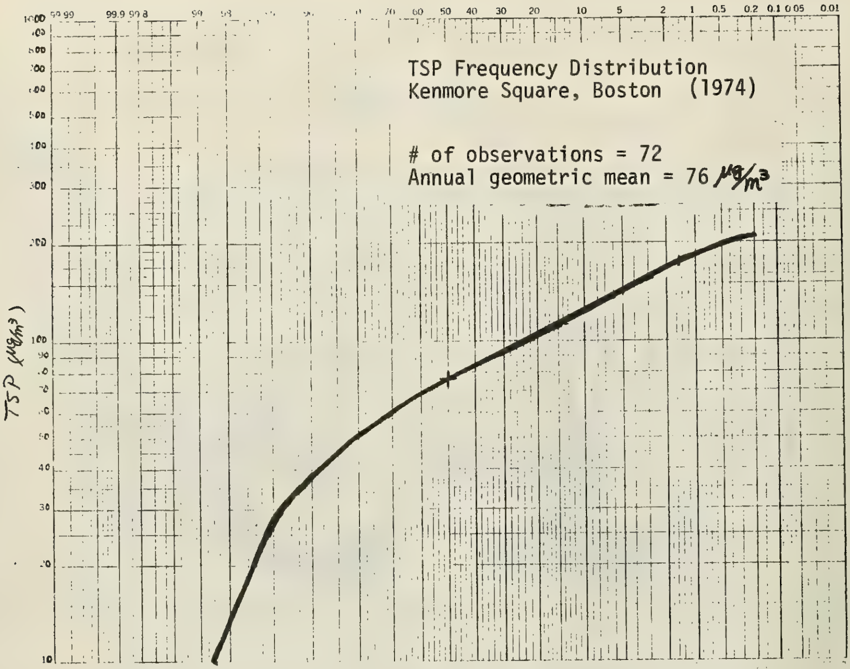
Figure 6



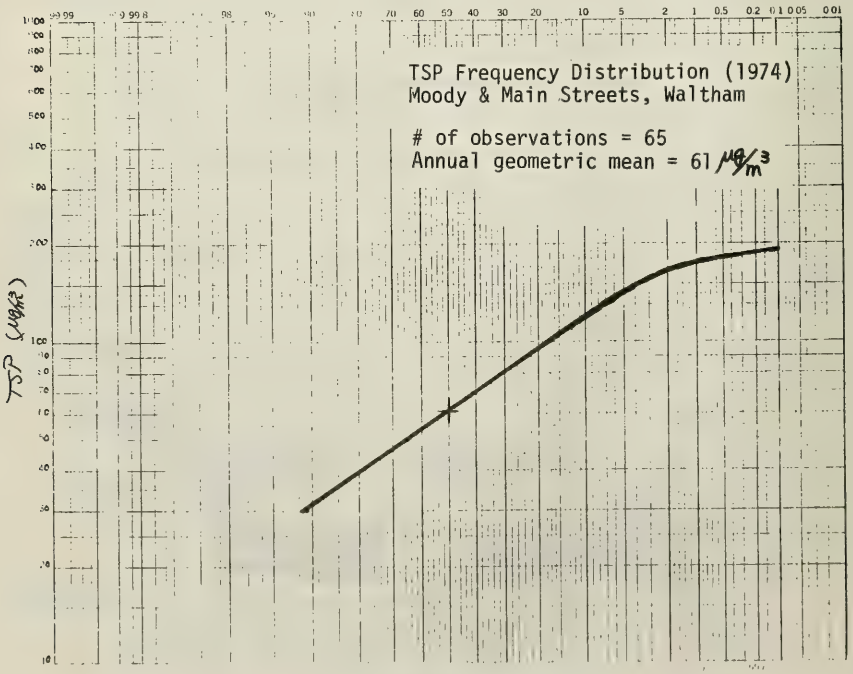
Science Park, Cambridge
TSP
(1974)
TSP 24-hr Concentration (μg/m³)
Number of Observations
(6) (10) (9) (10) (4) (4) (5) (5) (5) (5) (5)
NPAAQS1
MAAQS2
NSAAQS3
Maximum
Arith. Average
minimum
J F M A M J J A S O N D



Wellington Circle, Medford
TSP
(1974)
TSP 24-hr Concentration (μg/m³)
Number of Observations
(8) (9) (8) (9) (7) (4) (5) (3) (4) (5) (6)
NPAAQS1
MAAQS2
NSAAQS3
maximum
arith. mean
minimum
J F M A M J J A S O N D

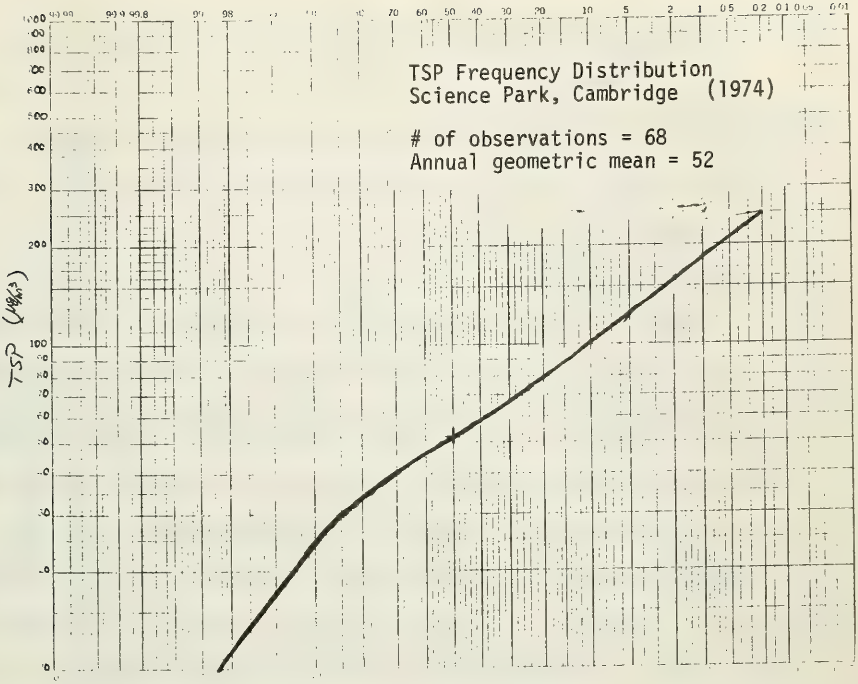


TSP Frequency Distribution
Kenmore Square, Boston (1974)
# of observations = 72
Annual geometric mean = 76 μg/m³
TSP (μg/m³)

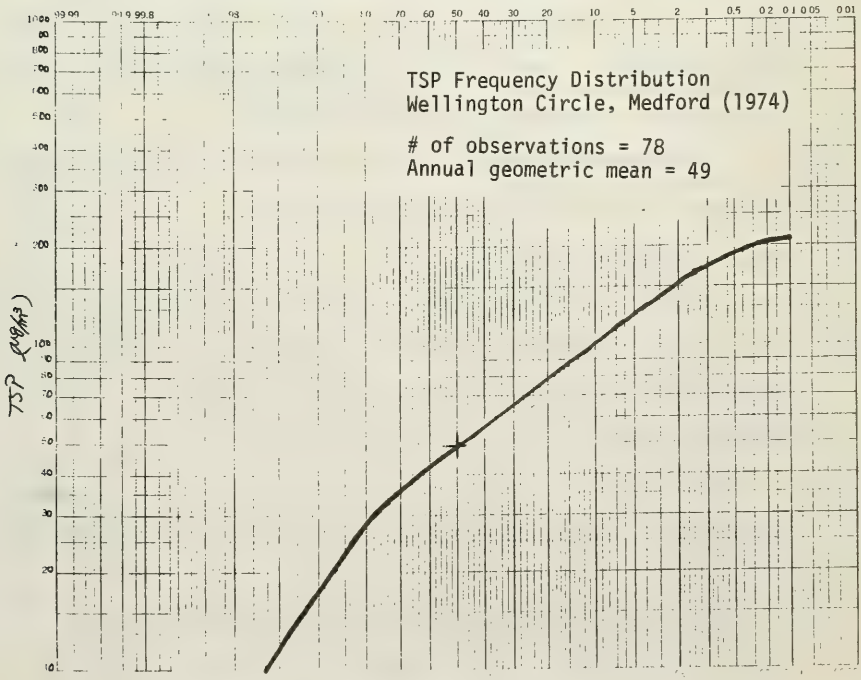


TSP Frequency Distribution (1974)
Moody & Main Streets, Waltham
# of observations = 65
Annual geometric mean = 61 μg/m³
TSP (μg/m³)

Figure 8



TSP Frequency Distribution
Science Park, Cambridge (1974)
# of observations = 68
Annual geometric mean = 52
TSP (µg/m³)



TSP Frequency Distribution
Wellington Circle, Medford (1974)
# of observations = 78
Annual geometric mean = 49
TSP (µg/m³)

As far as the MAAQS for total suspended particulates is concerned, Kenmore Square exceeded the 24 hour maximum level 1% of the time, Moody and Main Streets 0.5% of the time, Science Park 1.1% of the time, and Wellington Circle 0.7% of the time.

Sulfur Dioxide (SO_2)

Monthly 1 hour maximum SO_2 concentration is presented in Figures 9 and 10 for all four sampling stations. The reason for selecting the maximum 1 hour SO_2 levels for presentation is its convenience of showing occasions of violating either national or Massachusetts air quality standards. From the available data, no violation of the Massachusetts 1 hour maximum standard (0.280 ppm) was observed in 1974. It should be noted that the national secondary standard for maximum 3 hour SO_2 concentration (0.5 ppm) is less stringent than the state 1 hour standard. Therefore, conformance with the Massachusetts 1 hour standard automatically indicates no violation of national 3 hour standards.

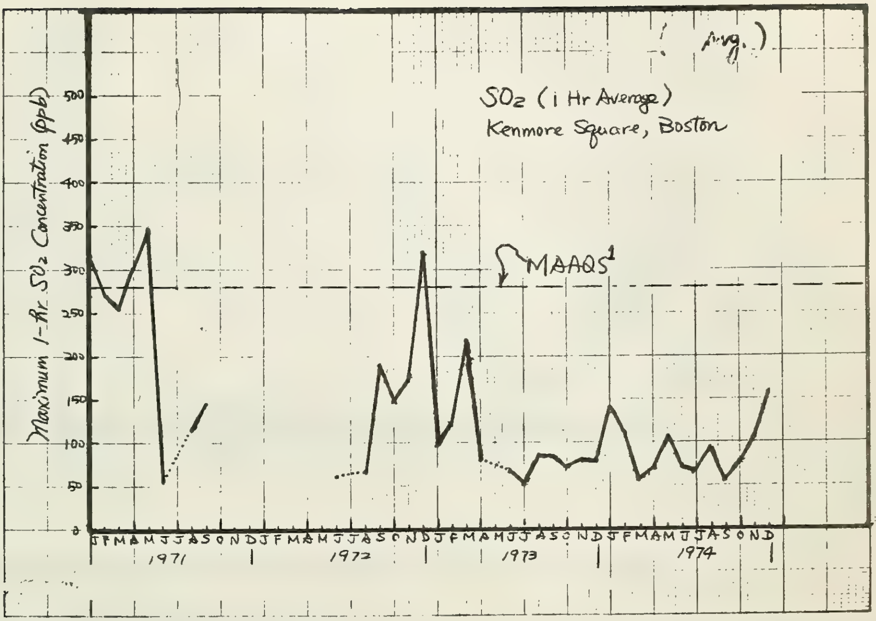
Any downward trend of SO_2 level cannot be concluded because complete data are not available.

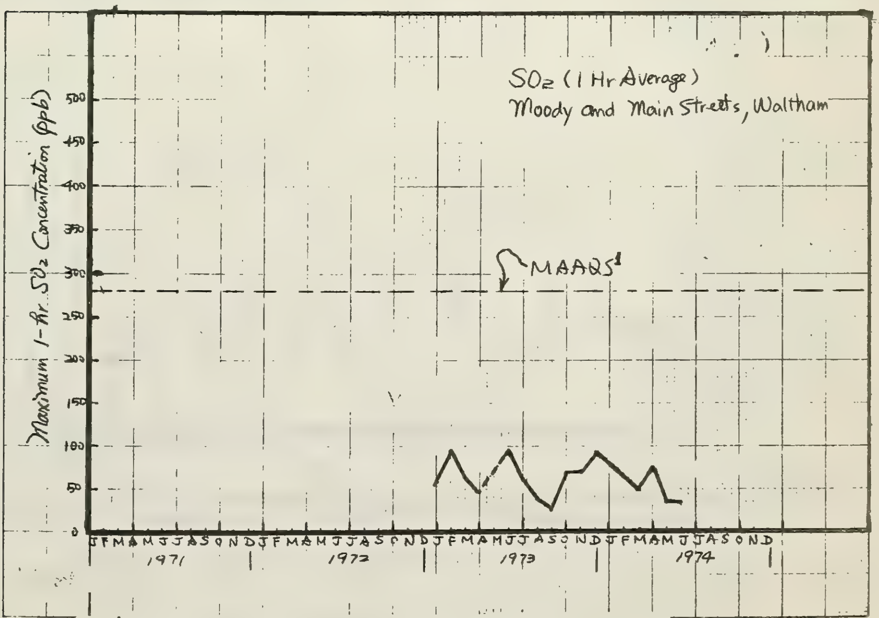
Photochemical Ozone (O_3)

Monthly maximum 1 hour ozone concentrations are presented in Figures 11 and 12. Numerous violations of federal and Massachusetts ozone standards were recorded at all four sampling stations (see Figures 13 and 14).

In Figures 11 and 12, the data indicate that higher ozone levels were more frequently observed in summer seasons

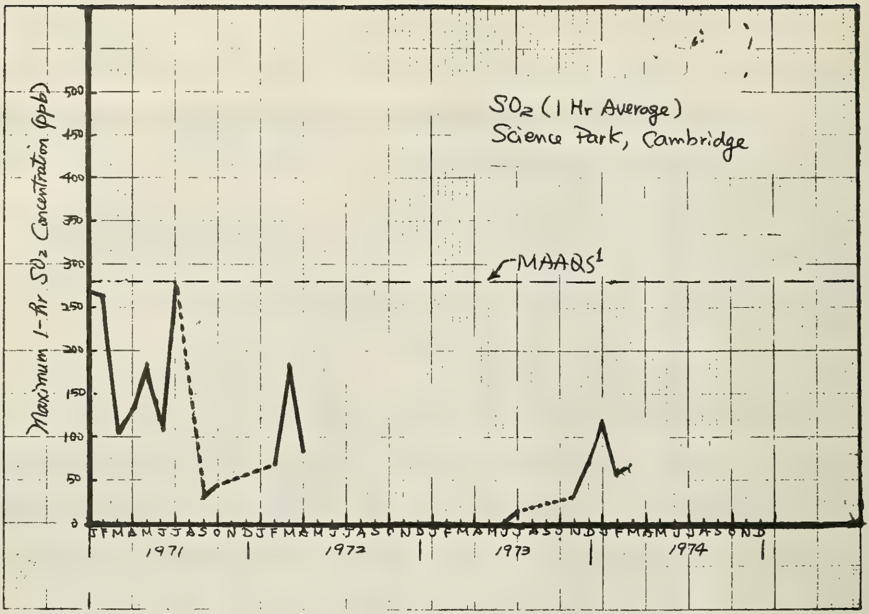
Figure 9

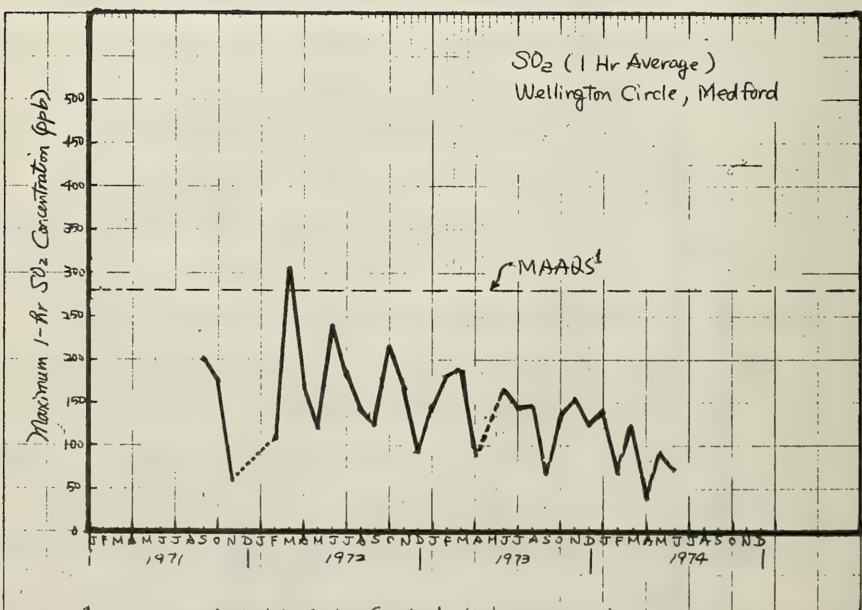




[1] Massachusetts Ambient Air Quality Standard (1 hr maximum)

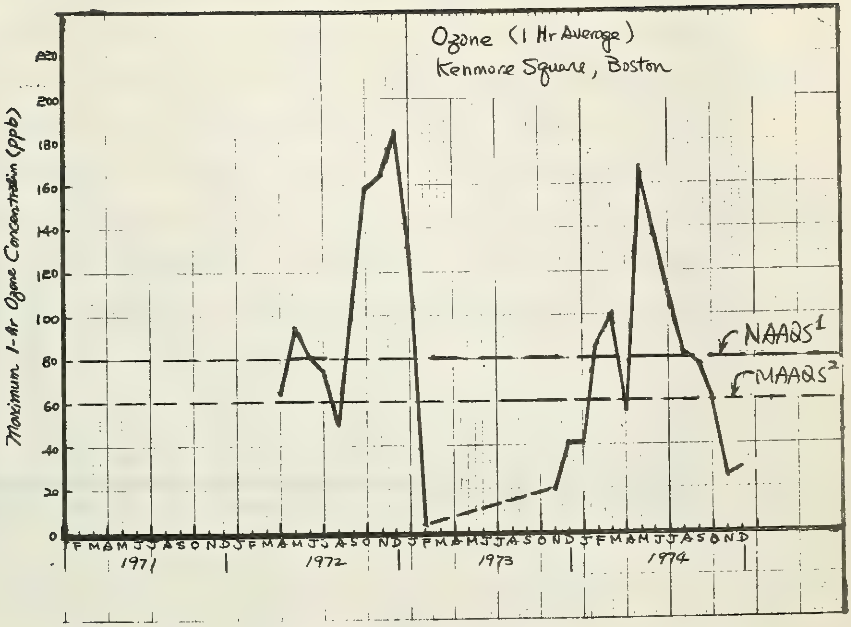
Figure 10

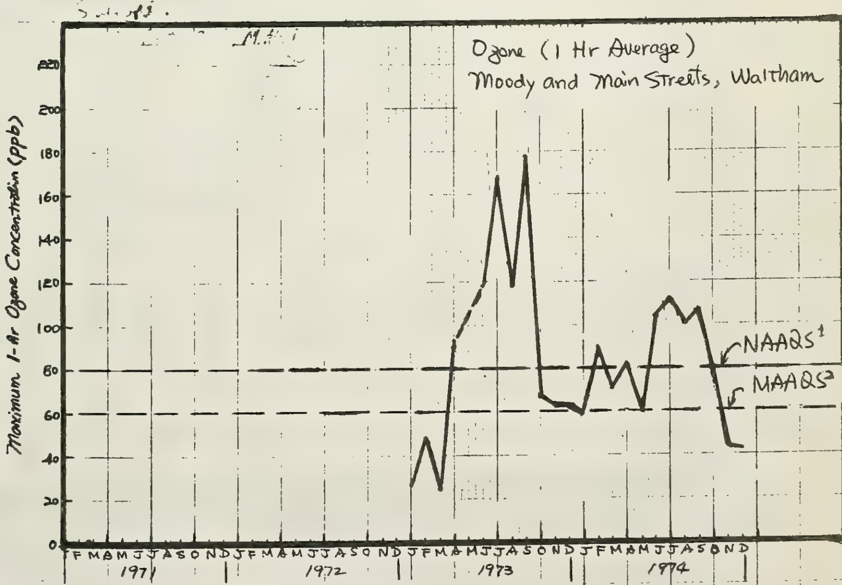




[1] Massachusetts Ambient Air Quality Standard (1 hr maximum)

Figure 11



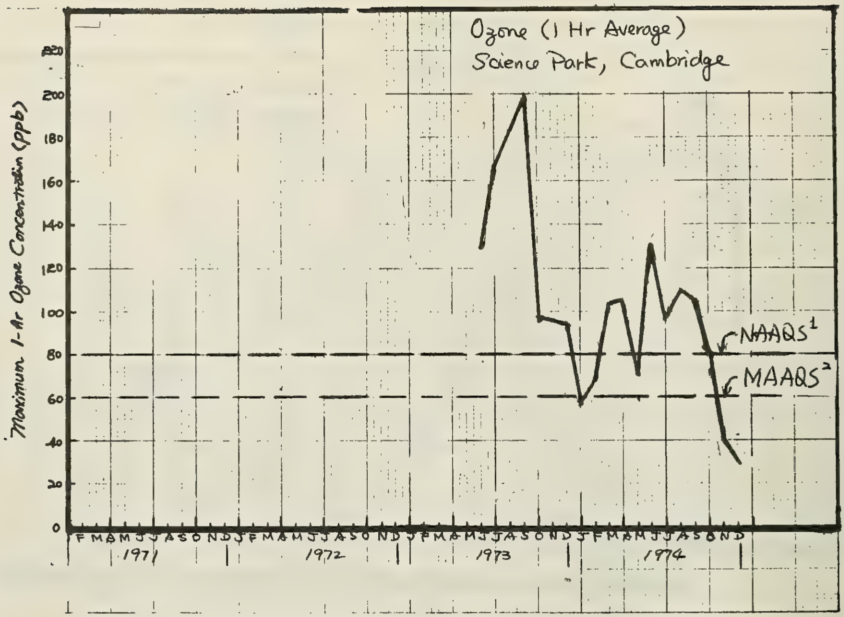


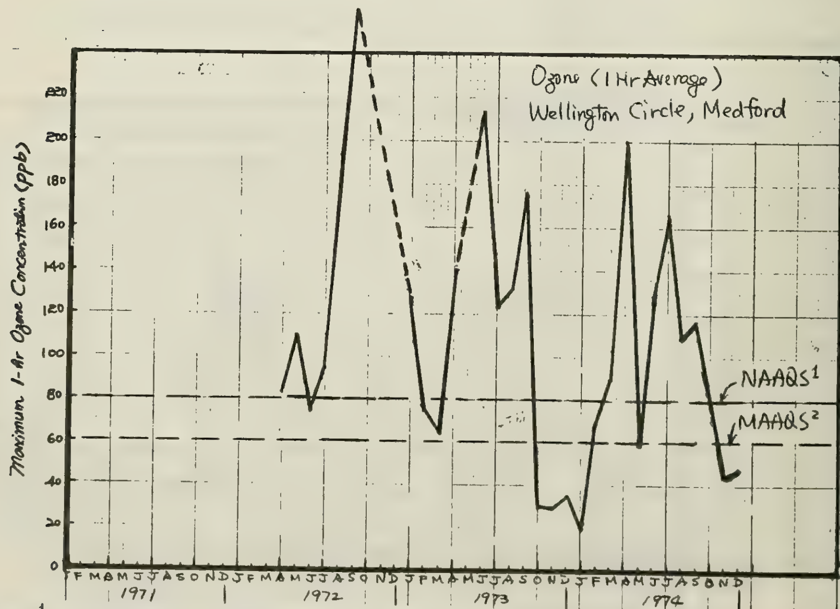
[1] National Ambient Air Quality Standard (1 Hr. maximum)

[2] Massachusetts Ambient Air Quality Standard (1 Hr maximum)

Note: dotted line indicating missing data

Figure 12





[1] National Ambient Air Quality Standard (1 Hr maximum)

[2] Massachusetts Ambient Air Quality Standard (1 Hr maximum)

Note: dotted line indicating missing data

(1972-1974) except at Kenmore Square and Wellington Circle in 1972. The association of higher photochemical activities with summer season is further confirmed by more violations of either NAAQS or MAAQS in summer seasons as indicated in Figures 13 and 14. This phenomena is probably partially due to higher solar insolation in summer. Similarity in ozone level delineated from the data collected by the four sampling stations indicates the photochemical pollution is a region-wide problem.

As can be seen in Figures 13 and 14, the maximum number of violations of the Massachusetts ambient air quality standards for hourly ozone level ranges from 38 times in September, 1972, at Wellington Circle to 60 times in July, 1973, at Science Park. Using the linear rollback model, the U.S. Environmental Protection Agency has indicated that a 69 percent[2] reduction of hydrocarbon emissions from 1972 is required through necessary transportation control plans in order to attain the national primary standard for photochemical oxidants in the Boston Air Quality Control Region.

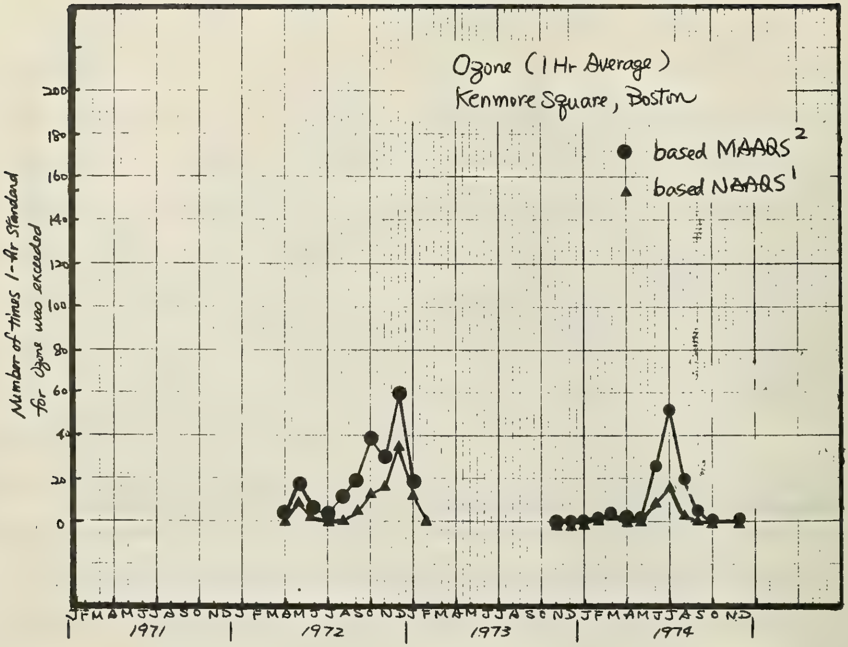
Carbon Monoxide (CO)

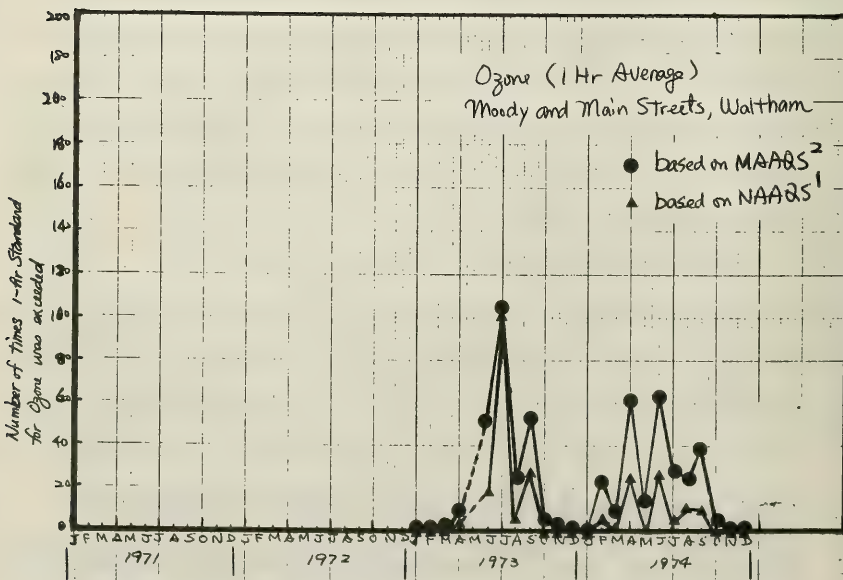
1. Eight-hour Running Average CO Levels [2]

As discussed in the section on emission analysis, CO is highly related to transportation activities in the region. Therefore, CO levels measured by a sampling station are influenced by the local traffic conditions. In addition, because carbon monoxide is rather inert in terms of atmospheric

[2] Promulgation of Transportation Control Plan, Boston, Massachusetts, U.S. EPA, Federal Register, Vol. 38, No. 215, November 8, 1973.

Figure 13

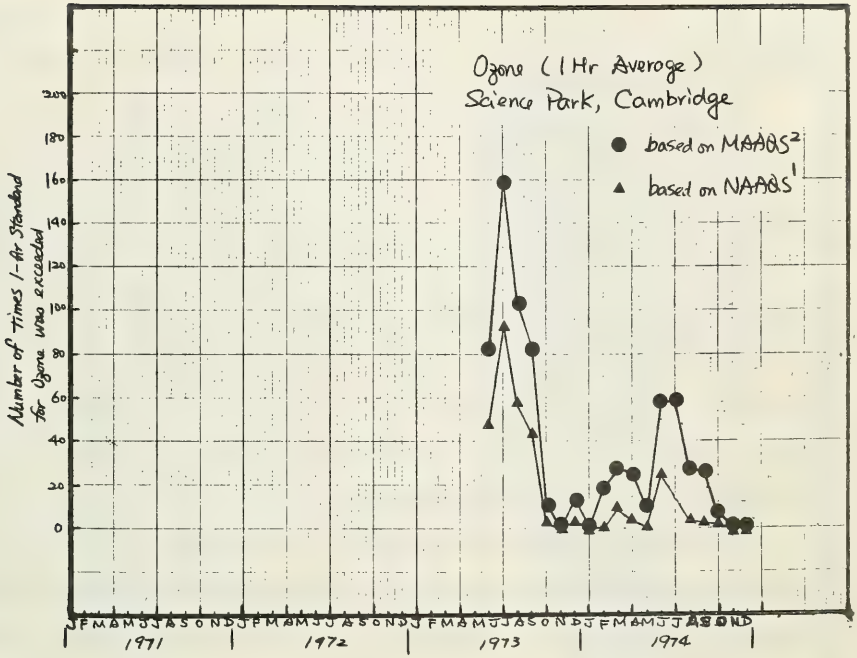


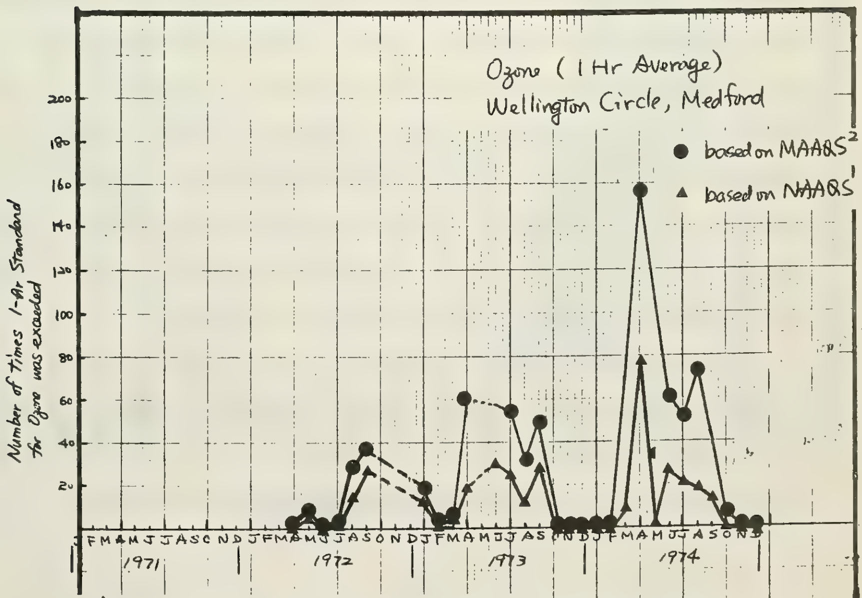


1 National Ambient Air Quality Standard (1 Hr Maximum)

2 Massachusetts Ambient Air Quality Standard (1 Hr. Maximum)

Figure 14 ______





[1] National Ambient Air Quality Standard (1 Hr. maximum)

[2] Massachusetts Ambient Air Quality Standard (1 Hr. maximum)

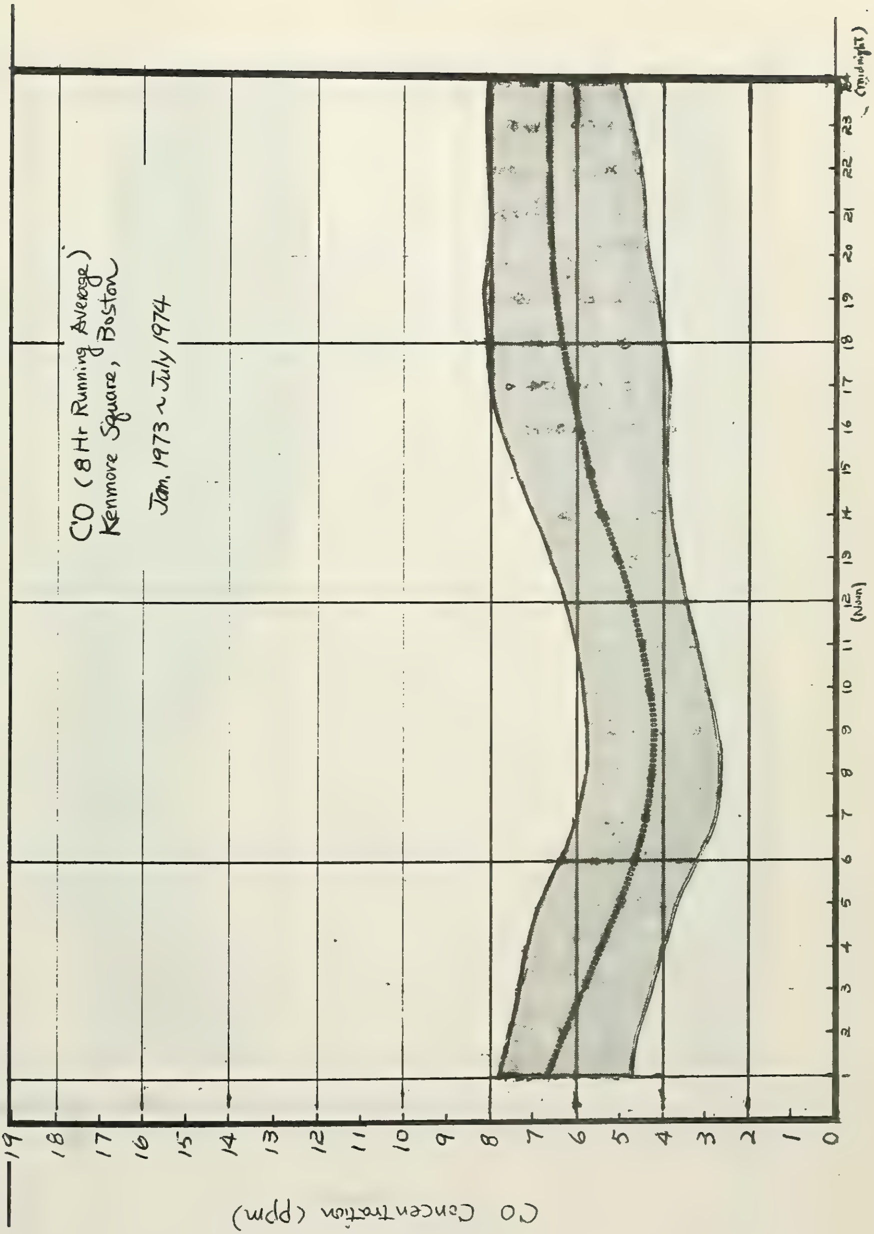
chemistry, accumulation of CO in the ground layer of air is possible in the presence of a persisting stable or stagnant atmosphere.

Since the seasonal and diurnal variations of traffic around a sampling station are not available, correlation between CO levels and local traffic activities is not attempted. It is worth noting that the correlation is even harder to accomplish if one recognizes the importance of wind field at the station site upon local CO level. To present CO levels without accurate knowledge of the local diurnal traffic variation and wind field can be achieved by the technique described in the following paragraphs.

For a given sampling station, the monthly mean of 8 hour running averages of CO (or 8 hour CO level) was calculated for each hour of the day. Taking Kenmore Square as an example, the same calculations were performed for the months from January, 1973, to July, 1974, and the results were plotted against the hour of day as shown in Figure 15. The results from the observations at Moody and Main Streets, Science Park, and Wellington Circle sites are shown in Figures 16, 17, and 18. The dotted line indicates the composite mean value of 8 hour running average CO levels, and the shaded area indicates the range of variation.

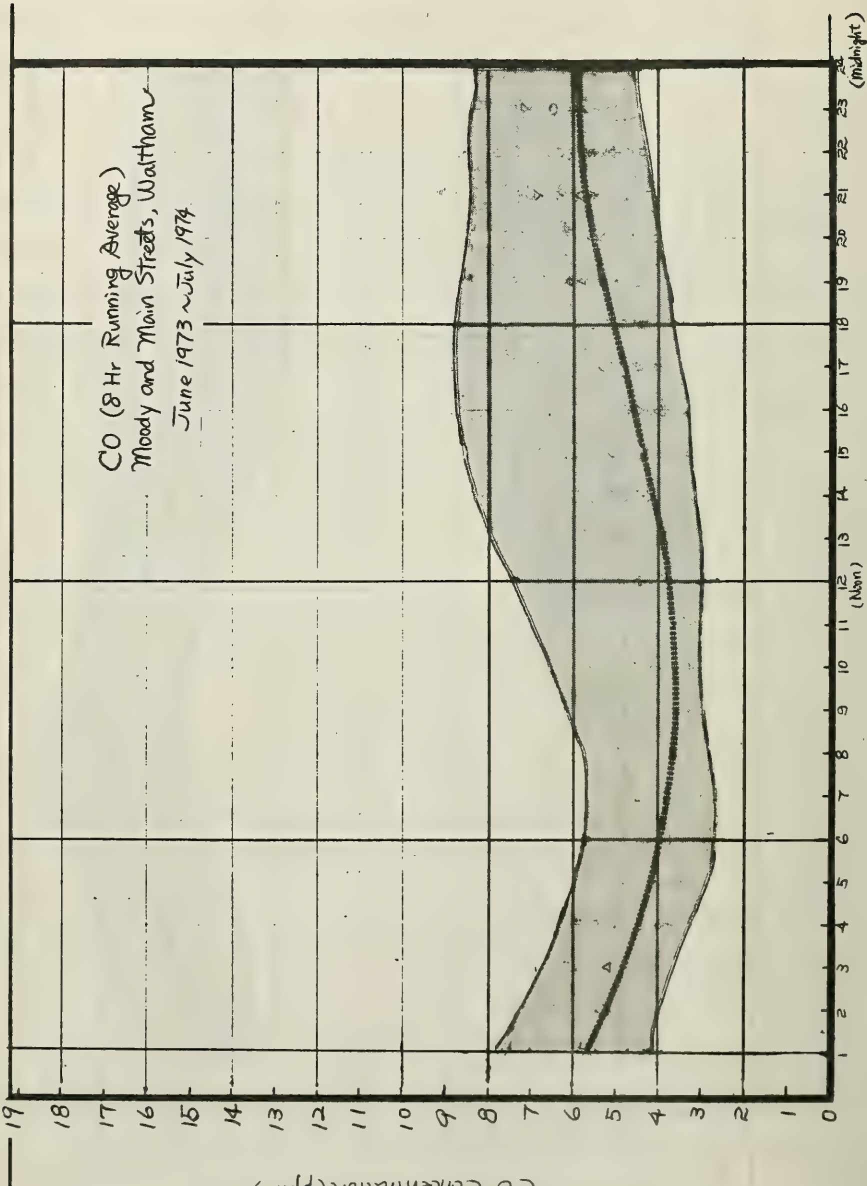
This mathematical treatment of field data enables us to approximate the CO levels of an average day during which most probable meteorological conditions prevail. The assumptions needed to support this approach are as follows:

Figure 15



CO (8 Hr Running Average)
Kenmore Square, Boston
Jan, 1973 ~ July 1974
CO Concentration (ppm)
12 (Noon)
24 (midnight)

Figure 16



CO (8 Hr Running Average)
Moody and Main Streets, Waltham
June 1973 ~ July 1974
CO Concentration (ppm)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
1 2 3 4 5 6 7 8 9 10 11 12 (Noon) 13 14 15 16 17 18 19 20 21 22 23 24 (midnight)

Figure 17

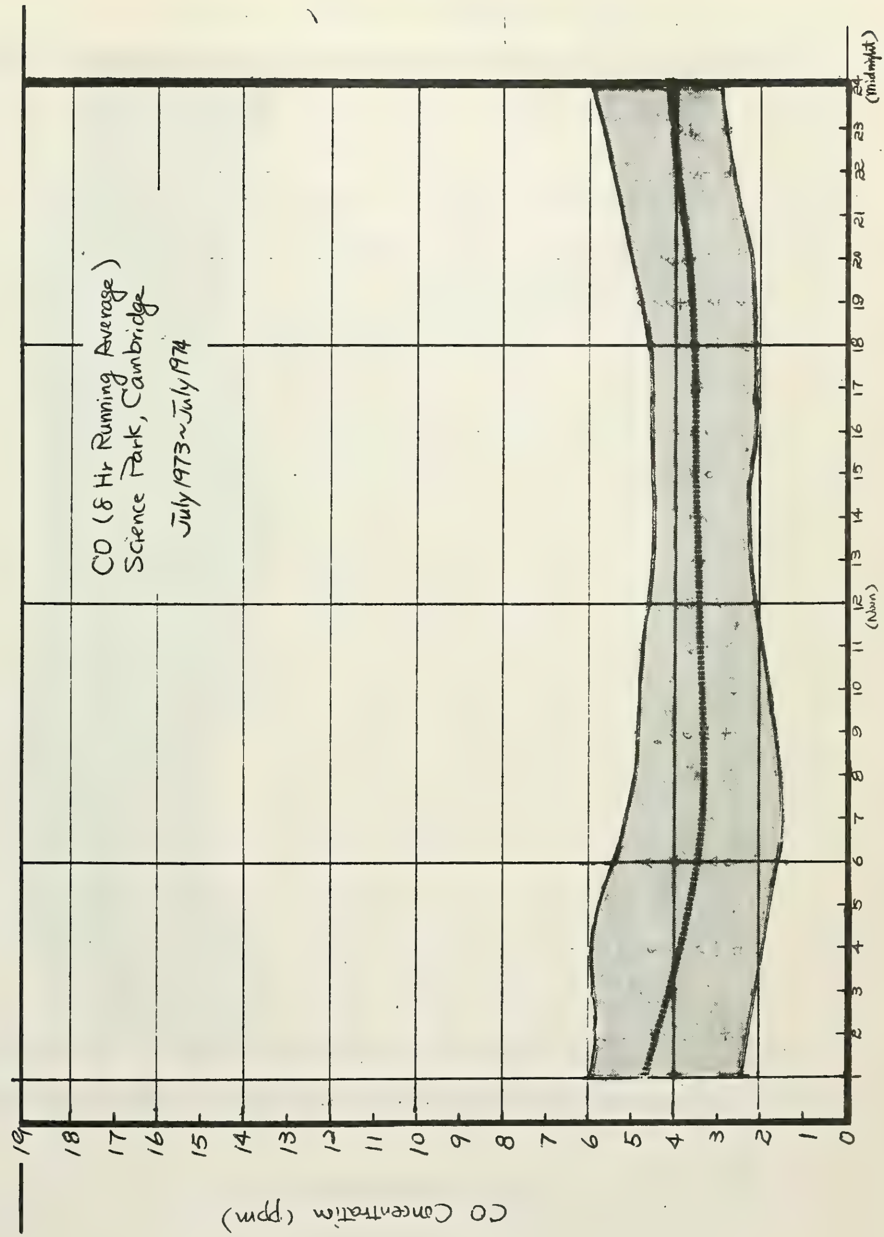
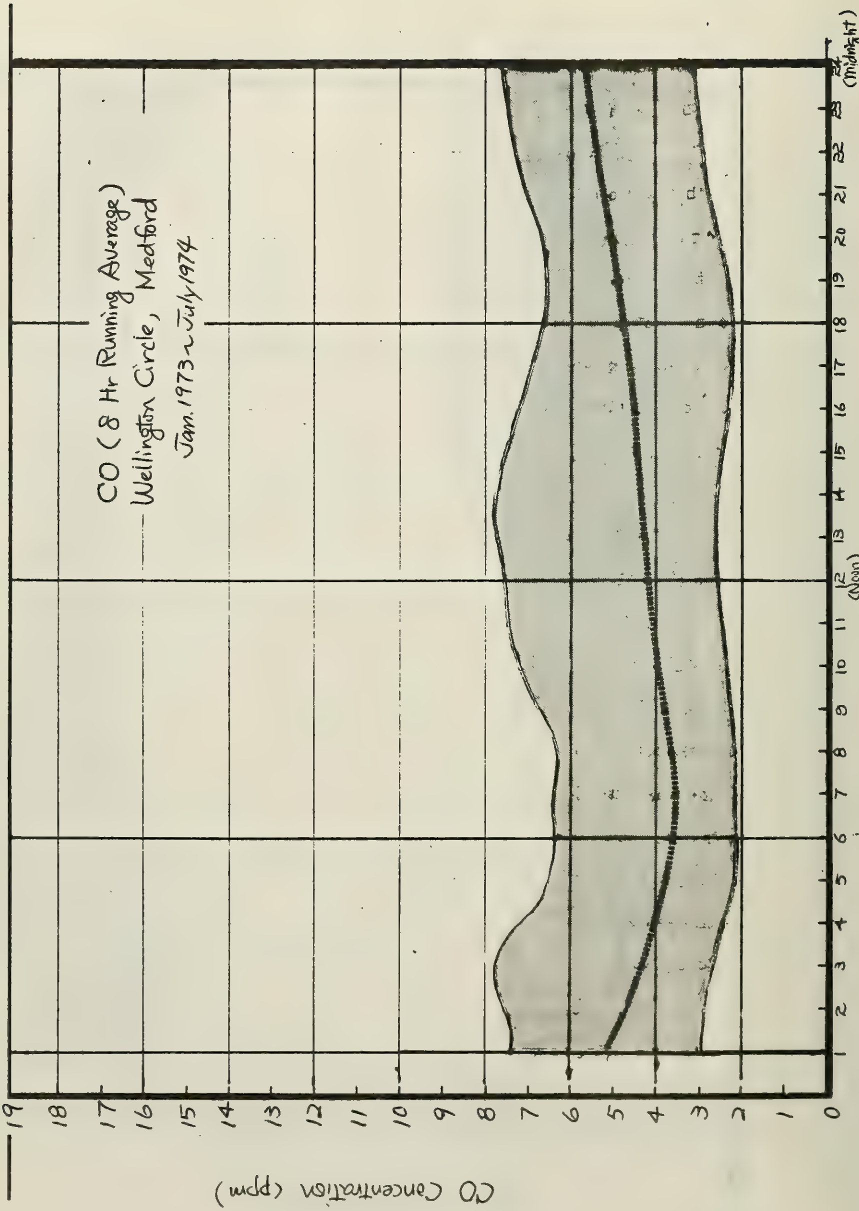

CO (8 Hr Running Average)
Science Park, Cambridge
July 1973~July 1974
CO Concentration (ppm)
12 (Noon)
24 (midnight)

Figure 18


CO (8 Hr Running Average)
Wellington Circle, Medford
Jan. 1973 ~ July 1974
CO Concentration (ppm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
1
2
3
4
5
6
7
8
9
10
11
12 (Noon)
13
14
15
16
17
18
19
20
21
22
23
24 (Midnight)

a. Each peak hour traffic period associated with higher daily 1 hour CO levels usually does not last very long (less than 2 hours) as compared to the averaging time of 8 hours; and

b. Unfavorable meteorological conditions, which favor unfamiliar high CO levels, occur so infrequently that their weight in this mathematical averaging process is insignificant.

The first assumption is validated by the fact that hourly levels of CO during peak traffic periods are higher than daily average hourly CO levels by no more that 40%. If this 40% excess of CO level is averaged out through an 8 hour period, its contribution is only approximately 5% of the 8 hour running average. The second assumption is quite true as discussed in the section on meteorology. In an entire year, the total number of approximately 10 forecast days of high meteorological potential for air pollution is considered insignificant by recognizing the data averaging period of nearly 1½ years.

In brief, this mathematical treatment on one hand smooths out atypically high CO levels associated with air pollution episodes and traffic congestions and, on the other hand, preserves some degree of sensitivity in revealing day to day meteorological and traffic variations in terms of 8 hour averaged CO levels.

The typical daily pattern of CO levels shown in Figures 15 to 18 is composed of a minimum CO level in the morning hours and then a gently climbing CO level before reaching

the evening hour plateau which is maintained most of the time through the nighttime hours.

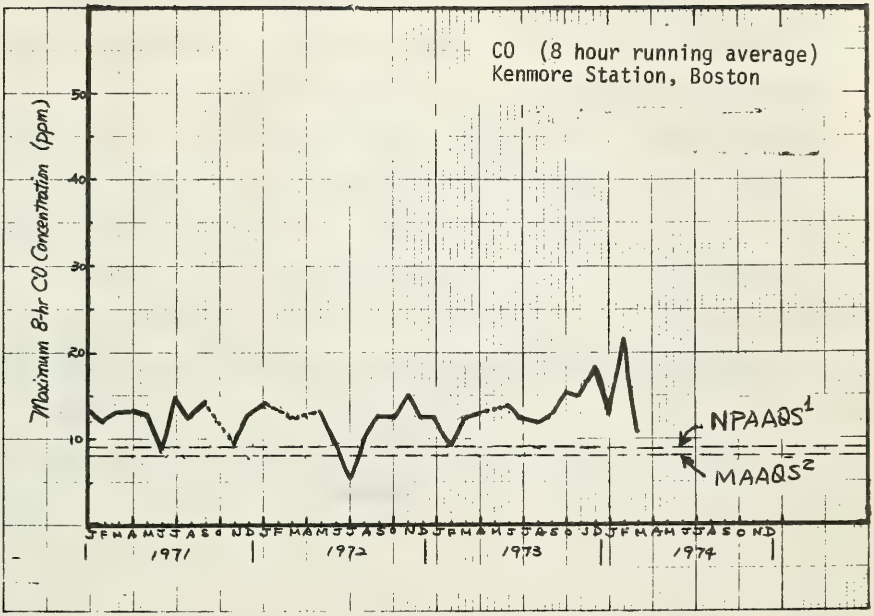
The low CO level in the morning hours is considered to be the result of the nocturnal ground inversion being eroded away by sun light and consequently more mixing depth and mechanical turbulence for the dispersion and dilution of CO despite more CO emission due to morning rush hours. Constant high levels of CO in the evening and through the night are attributed to the limited dispersion or trapping which is brought about by nocturnal build-up of ground inversion of CO emissions from afternoon rush hours.

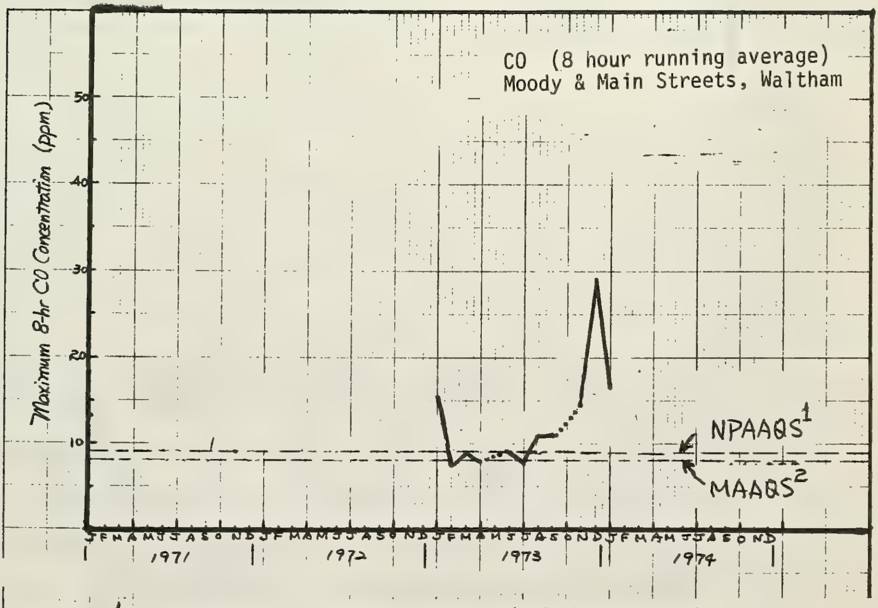
Comparison study for CO levels at four sites suggests that Kenmore Square site generally has the highest CO concentrations year round, and Science Park site the lowest. However, this observation does not preclude the possibility of having the worst CO level at Science Park, simply because, as repeatedly discussed previously, these exhibits represent averages for a typical day.

2. Maximum 8 Hour Running CO Levels

In order to assess the existing CO problems, maximum 8 hour running CO levels as a function of the month of a year are plotted and shown in Figures 19 and 20. From these exhibits, it is concluded that 9 hour CO standards are violated frequently. From the available data, the maximum 8 hour CO level at Kenmore Square is 21.5 ppm; Moody and Main streets, 29.5 ppm; Science Park, 19 ppm; and Wellington Circle, 21.5 ppm. The number of violations of either the

Figure 19

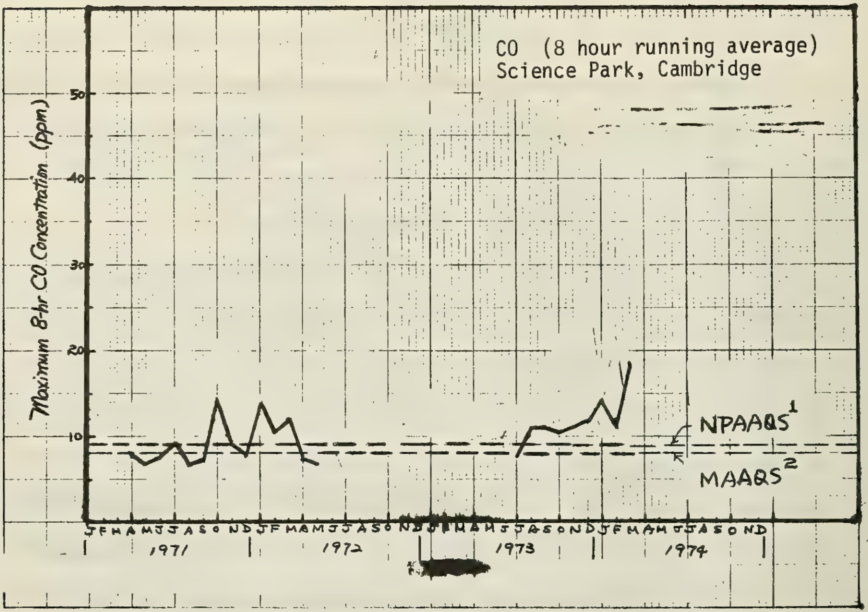


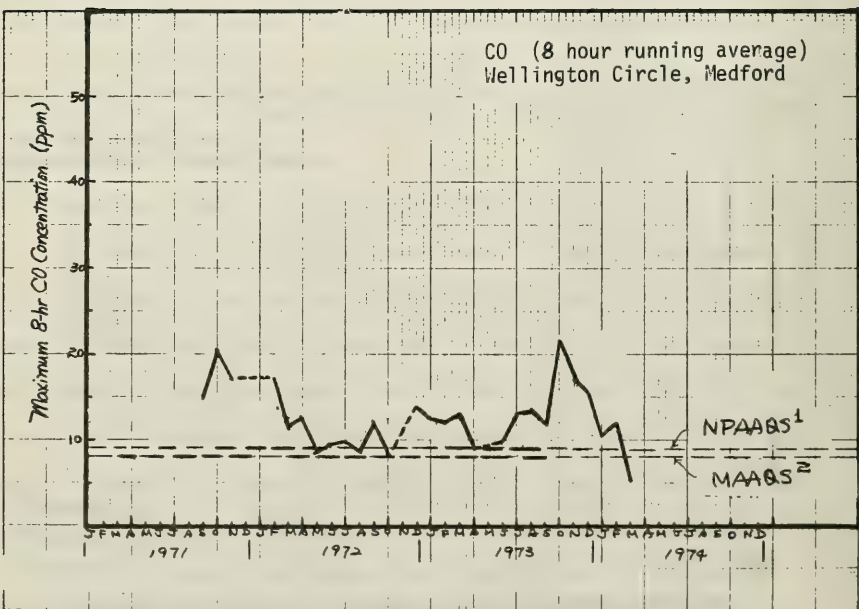


[1] National Primary Ambient Air Quality Standard (8 hr maximum)

[2] Massacusetts Ambient Air Quality Standard (8 hr maximum)

Figure





[1] National Primary Ambient Air Quality Standard (8 hr maximum)

[2] Massachusetts Ambient Air Quality Standard (8 hr maximum)

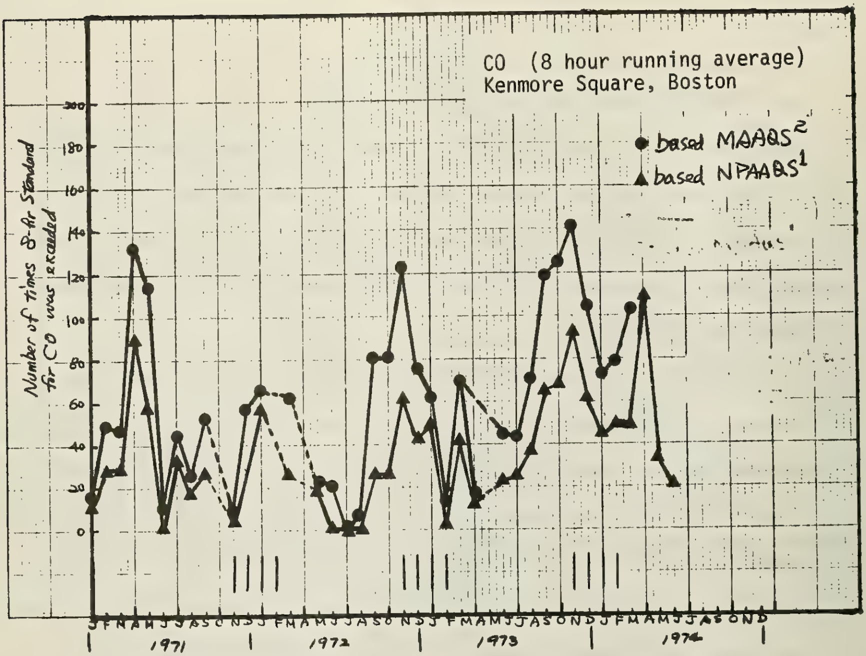
national or the Massachusetts standards are presented in Figures 21 and 22. Highest number of violations per month of the air quality standards of the Commonwealth of Massachusetts is 141 times at Kenmore Square, 147 times at Moody and Main Streets, 28 times at Science Park and 160 times at Wellington Circle.

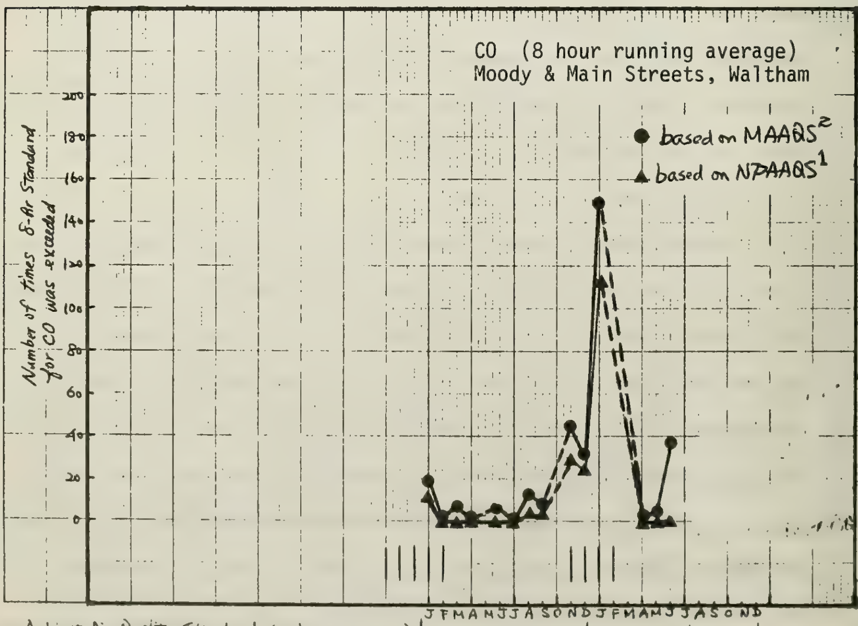
Results of the probability study of CO measurements shown in Figures 23 and 24 indicate an approximate log-normal distribution (straight line) for 8 hour CO levels higher than 4 ppm for all sampling stations other than the Moody and Main Streets site. The probability of violating the national 8 hour CO standard is 10% of the time at Kenmore Square, 4.5% at Moody and Main Streets, 1.7% at Science Park, and 5% at Wellington Circle. The probability of violating 8 hour CO standard of the Commonwealth of Massachusetts is 17% at Kenmore Square, 8% at Moody and Main Streets, 2.8% at Science Park and 9% at Wellington Circle.

3. 1 Hour Maximum CO Levels

The maximum 1 hour CO levels at the four sampling stations vs. the month of the year are shown in Figures 25 and 26. The exhibits show qualitatively the probability of violating the National Primary Ambient Air Quality Standard (35 ppm) for 1 hour CO level at each station. The highest 1 hour CO level encountered at Kenmore Square was 32 ppm in 1974; 46 ppm at Moody and Main Streets in 1973 and 33 ppm in 1974; 35 ppm at Science Park in 1974 (equals the NAAQS); and 30 ppm at Wellington Circle in 1971.

Figure

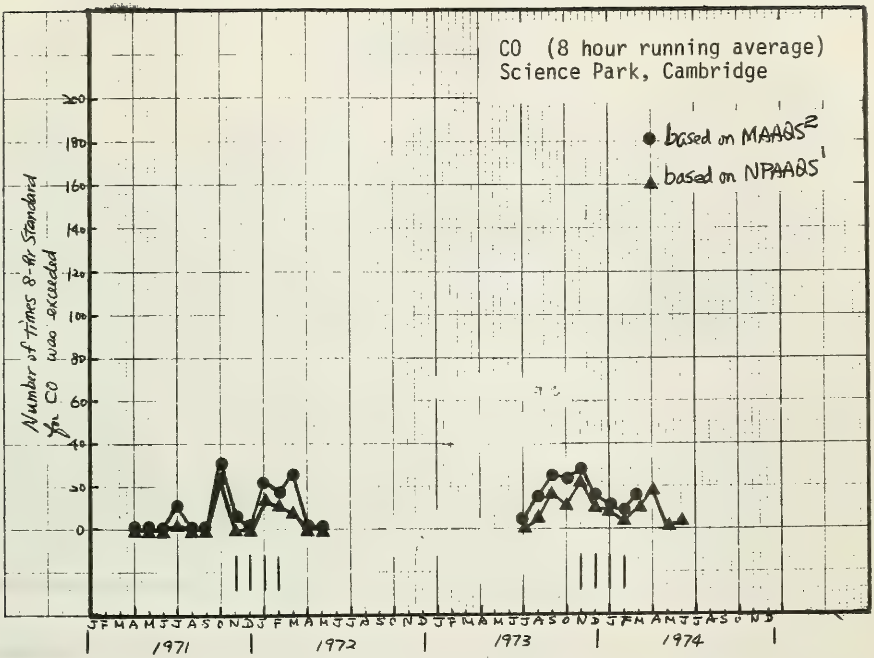


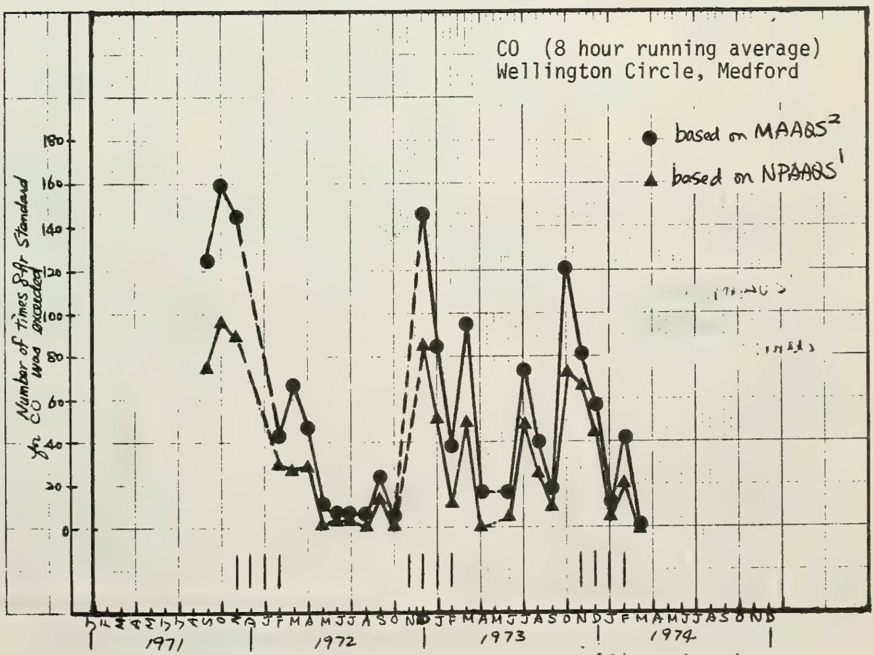


1 National Primary Ambient Air Quality Standard (8 hr maximum)

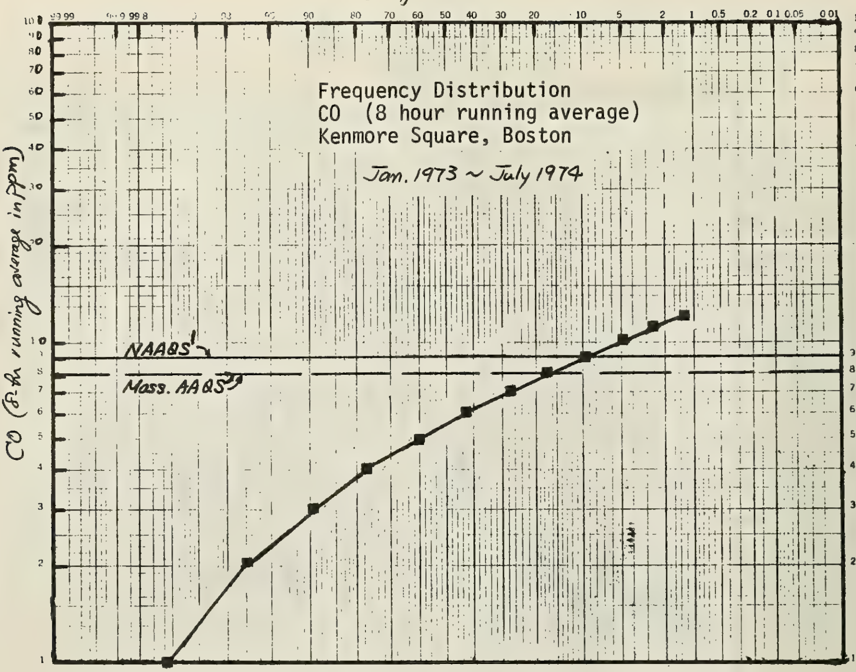
2 Massachusetts Ambient Air Quality Standard (8 hr maximum)

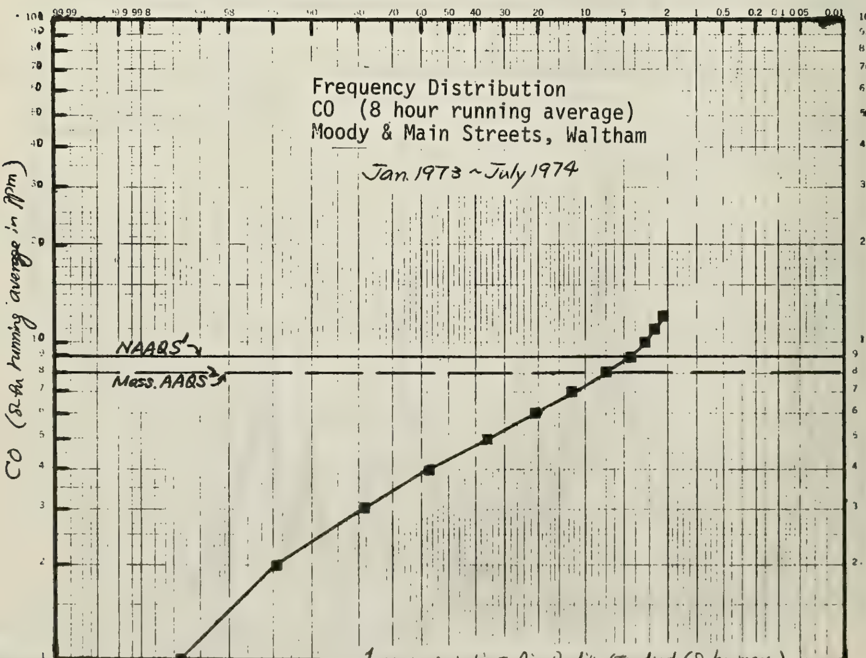
Figure 22





[1] National Primary Ambient Air Quality Standard (8 hr maximum)
[2] Massachusetts Ambient Air Quality Standard (8 hr maximum)

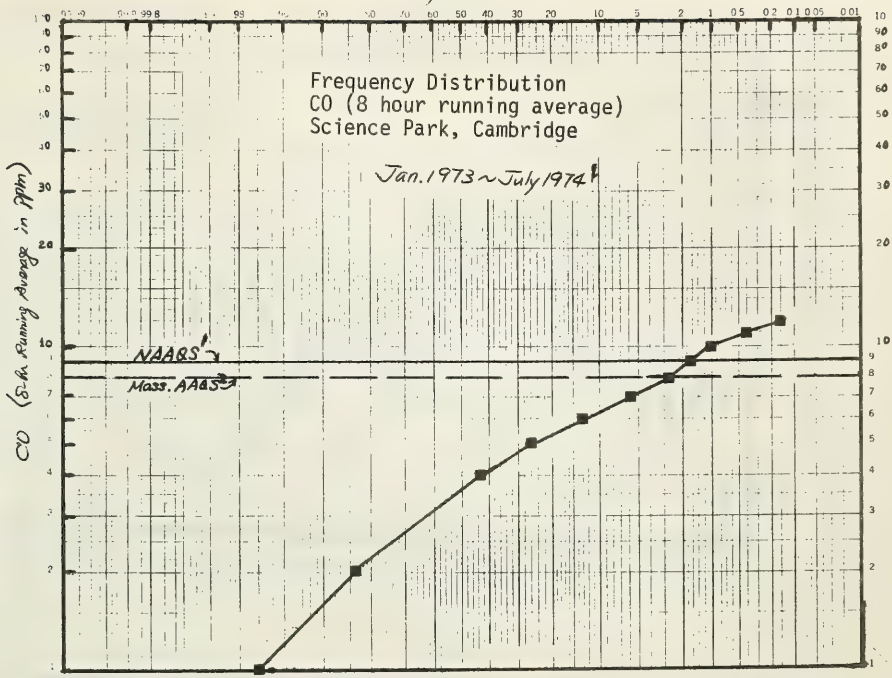


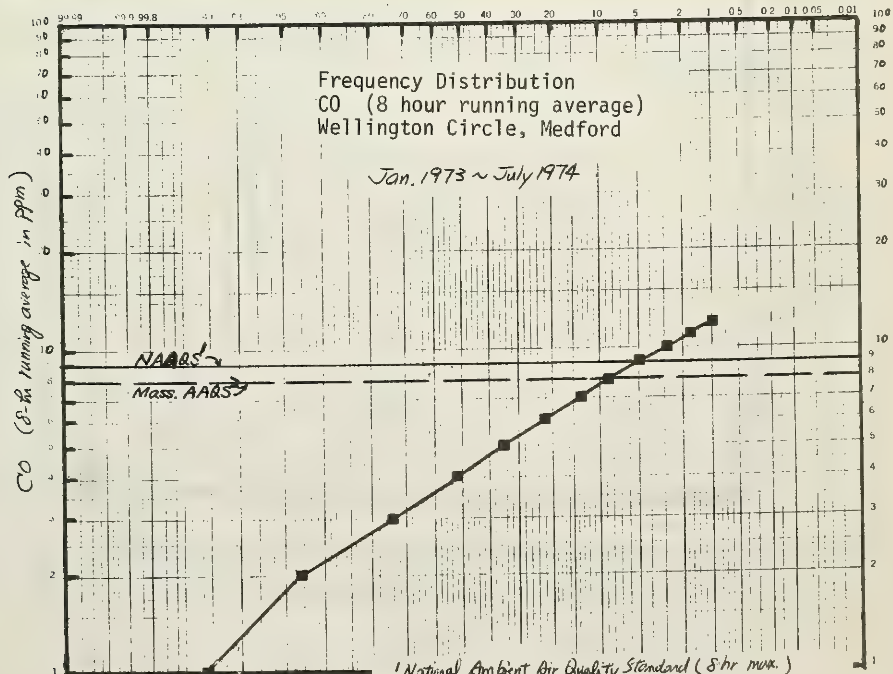


[1] National Ambient Air Quality Standard (8 hr max.)

[2] Massachusetts Ambient Air Quality Standard (8 hr max.)

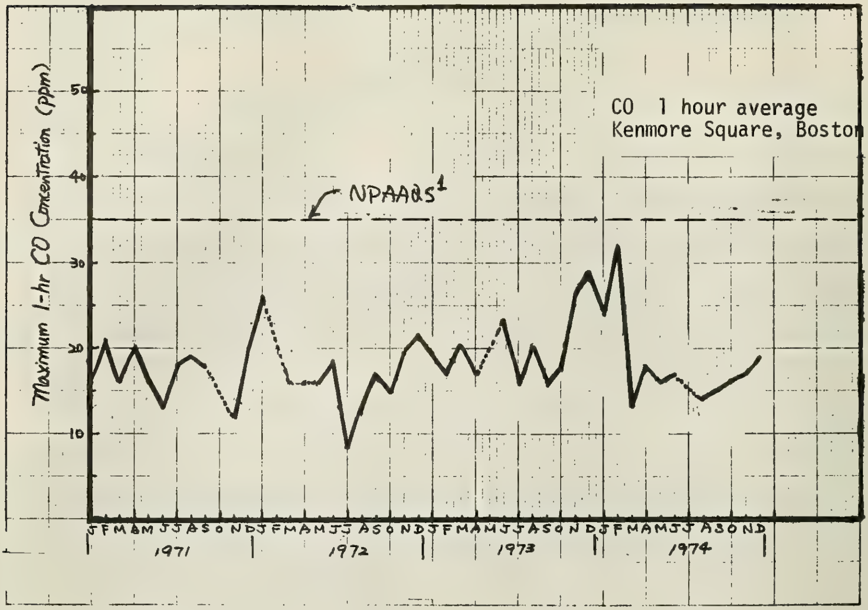
Figure 24

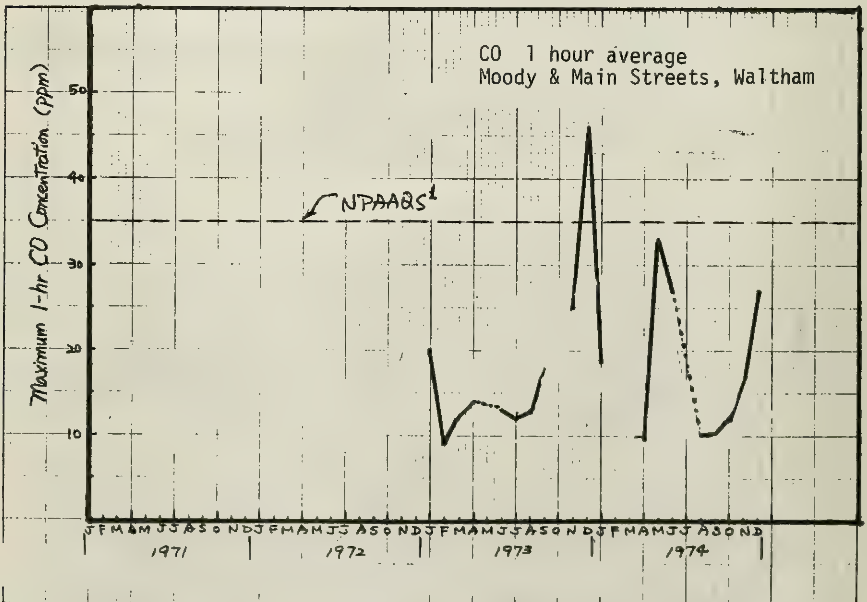




[1] National Ambient Air Quality Standard (8 hr max.)
[2] Massachusetts Ambient Air Quality Standard (8 hr max.)

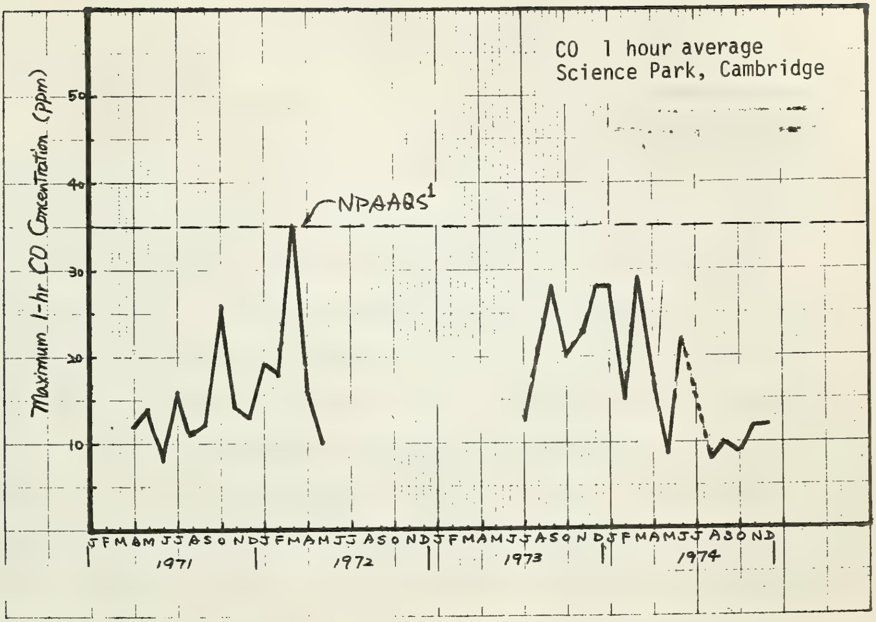
Figure 25

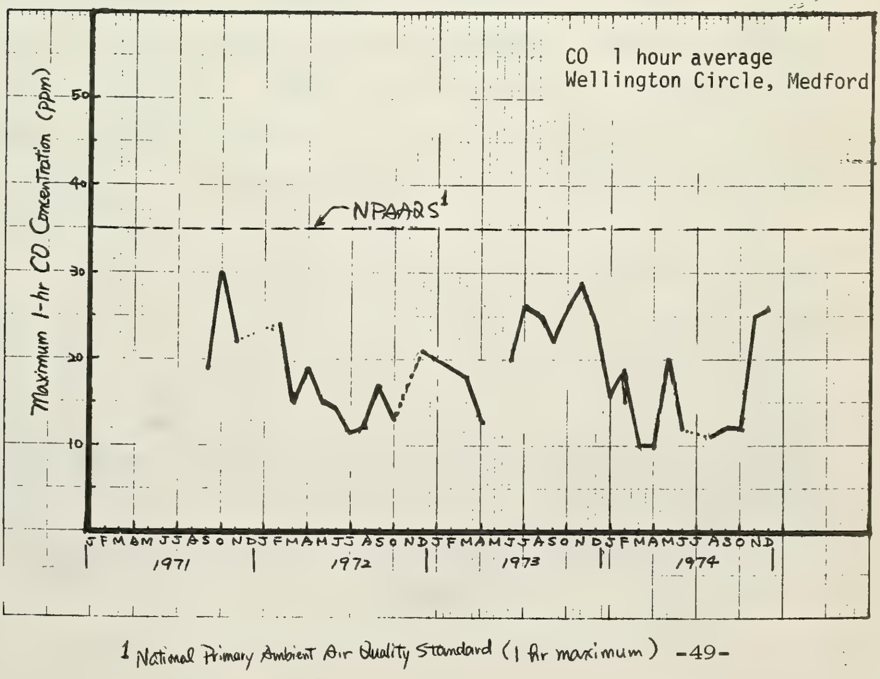




[1] National Primary Ambient Air Quality Standard (1 hr maximum)

Figure 26





[1] National Primary Ambient Air Quality Standard (1 hr maximum)

Seasonal patterns of CO concentrations are not observed due to insufficient data. It is obvious that the 1 hour CO standards are conformed to most of the time with a few exceptions.

D. AIR QUALITY ANALYSIS--A COMPARATIVE STUDY

Computer Modeling

Rooftop CO levels throughout the corridor under study are modeled by the APRAC-lA computer program. The APRAC-lA urban diffusion model was developed to simulate CO concentrations from associated meteorological and traffic data. For intraurban transportation and dispersion of CO, the computer model uses the "Gaussian plume" diffusion formulation for all the sources close to the receptor and uses a simple "box" model to replace the Gaussian plume model when the source and receptor distance is long enough to satisfy given conditions.[1,2] Two types of CO emission sources, namely line and area sources, are differentiated and read into the model separately. The 3½ X 12 mile study area covers all Red Line Extension alignments and five related municipalities--Arlington, Belmont, Cambridge, Lexington and Somerville. Base year cases (1974) and target year cases including build and no build alternatives were modeled and studied to investigate any possible impact on air quality by the proposed project.

The data required by the model can be categorized into three groups: emission factors, traffic data and meteorological data. Each of them is discussed separately in the following sections.

[1] "User's Manual for the APRAC-lA Urban Diffusion Model Computer Program", R.L. Mancuso and F.L. Ludwig, SRI, September, 1972.

[2] "Evaluation of the APRAC-lA Urban Diffusion Model for Carbon Monoxide", P.L. Ludwig and W.F. Dabberdt, SRI, 1972.

1. Emission Factors

The most recent emission factors suggested[3] by the U.S. EPA are employed along with the necessary adjustments for average vehicle speed and deterioration of emission control devices in terms of model year and age, weighted travel by age of vehicle, vehicle distribution by model year, mixture of light and heavy duty vehicles. The emission factors in terms of average vehicle speed are shown in Figure 26 for both the base and target years.

2. Traffic Data Input

Traffic data is established by utilizing the BTPR report[4] (The Red Book) prepared for the Department of Public Works and Massachusetts Bay Transportation Authority, the areawide TOPICS studies [5] for the five municipalities, and <u>Transportation Facts for the Boston Region (1968/1969).</u>

Traffic volumes in 1970 on primary traffic links are delineated from the TOPICS studies. The traffic volumes in the base year (1974) are then estimated by the growth factors extracted from the trend of vehicle registration in each municipality. The same procedure is also used to establish the traffic volumes in the target year (1980).

The daily VMT (vehicle mile travel) on the primary traffic

[3] <u>Compilation of Air Pollutant Emission Factors</u>, U.S. EPA, Office of Air and Water Programs, Publication No. AP-42, Fifth Edition, Research Triangle Park, N.C., July, 1975.

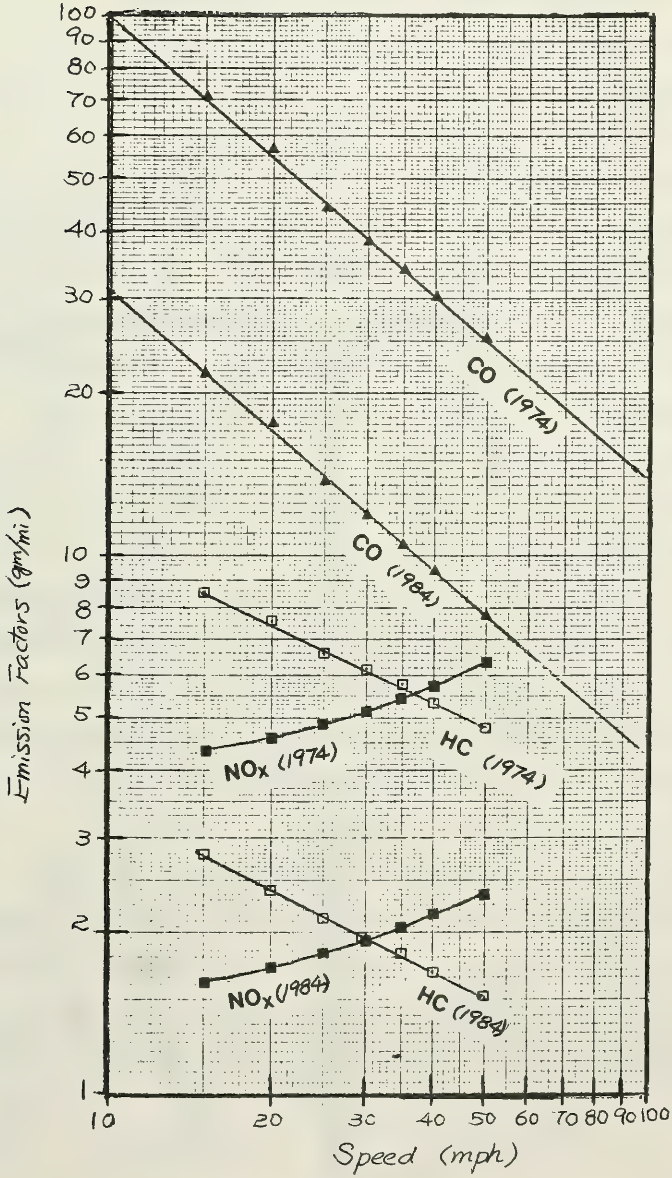
[4] <u>Boston Transportation Planning Review--Northwest Corridor, A Preliminary Environmental Analysis</u>, Department of Public Works and Massachusetts Bay Transportation Authority, January, 1973.

[5] Tippets-Abbett-McCarthy-Stratton, Engineers and Architects, <u>Areawide TOPICS Plans</u> (Traffic Operations Programs to Increase Capacity and Safety) for Arlington, Belmont, Cambridge, Lexington and Somerville, Massachusetts, Commonwealth of Massachusetts, Department of Public Works, Boston, Massachusetts, November, 1972.

Figure 26

~~Exhibit~~

Emission Factors vs Traffic Speed



network is the summation of the products of daily vehicle flow and traffic link length. The primary VMT, i.e., the VMT on primary traffic links, as shown in Figure 27, is treated in the simulation program as line sources. Secondary VMT deduced from the BTPR report is expressed in percentage of the primary VMT for a given municipality and is regarded as area sources in the computer program.

As reported in BTCP[6], the maximum one hour traffic peak is considered to be 10% of the total average daily traffic (ADT) and the maximum 8 hour traffic is 50% of the total ADT.

Finally, linkage between VMT and emission factors is provided by the traffic coding as shown in Table 6 to yield the emission strength of a given source.

3. Meteorological Data Input

Important meteorological variables required by the simulation model are transport wind, mixing depth and stability of atmosphere. The mixing depth is calculated using the surface temperature observation at Logan International Airport, and the U.S. Weather Service's nearest morning (1200 GMT) upper air temperature sounding conducted at Chatham, Massachusetts. The stability index is evaluated by the prevailing cloud cover and wind speed.

Worst and most probable meteorological conditions, evolved from the wind rose analysis, the probability analysis of the historic atmospheric stability data aided with the

[6] GCA Corporation, Transportation Controls to Reduce Motor Vehicle Emissions in Boston, Massachusetts (Boston Transportation Control Plan), U.S. EPA Office of Air and Water Programs, Research Triangle Park, N.C. December, 1972.

Figure 27 ~~Exhibit~~ Primary Traffic Links for Air Quality Modeling

★ Red Line Extension Station Areas

~~Exhibit~~ Table 6

Facility Codes and Car Speeds for Metropolitan Boston Region

Traffic Link Type	Traffic Code	Speed (mph)
INNER & OUTER SUBURB		
• Freeway	1	50
• Arterial	2	40
• Collector	3	30
INNER CITY		
• Freeway	4	25
• Arterial or Collector	5	15
INNER or OUTER SUBURB		
• Local	6	20
INNER CITY		
• Collector	7	16
• Local	8	15

radiosonde observations at Chatham, and carbon monoxide measurements at four state-operated air quality sampling stations are adopted for computation input.

The worst conditions are 1 m/sec wind, 100 meter mixing depth and Pasquill stability class D. The most probable conditions are 1000 meters in mixing depth, 14 m.p.h. wind and stability class E.

Alternative Cases

Considering the possible alternative combination of various traffic and meteorological conditions, 12 cases of modeling are considered necessary to give a complete disclosure of air quality impact resulting from the proposed project. The conditions of these 12 cases are described in Table 7.

It should be noted in Table 7 that the worst 1 hour cases, i.e., case 1(a), 1(b), and 1(c) are in fact the worst of the worst cases with simultaneous occurrence of peak 1 hour traffic and worst meteorological conditions, of which the joint probability of occurrence is undiscernably small.

Spatial Distribution of Emission Sources

A Cartesian coordinate system is superimposed on the corridor area to define the geographical locations of all emission sources. Line sources of emission are represented by the network of primary traffic links located by the coordinates of the linkends. Part of the primary link network is shown in Figure 27.

A grid systemwith a grid size of 2 X 2 miles is employed to describe the distribution of area sources within the

Table 7

Air Quality Evaluation Cases

Conditions	Base Year (1974)	Target Year, No-Build (1984)	Target Year, Build (1984)
Traffic : 1 Hour Peak Meteorology : Worst Conditions	Case 1(a)	Case 1(b)	Case 1(c)
Traffic : 8 Hour Maximum Meteorology : Worst Conditions Lasting for 8 Hours	Case 2(a)	Case 2(b)	Case 2(c)
Traffic : 1 Hour Peak Meteorology : Most Probable Conditions	Case 3(a)	Case 3(b)	Case 3(c)
Traffic : 8 Hour Maximum Meteorology : Most Probable Conditions Lasting for 8 Hours	Case 4(a)	Case 4(b)	Case 4(c)

corridor. Assumption is made that the CO emissions (besides those from the primary traffic links) surrounding a grid point are contributed uniformly from an entire 2 X 2 mile grid by the VMT on secondary traffic links within the grid. The whole emission grid system is presented in Figure 28.

Construction of CO Level Contour Maps

A total of 333 receptor sites shown in Figure 29 are distributed uniformly to cover the 3½ X 12 mile study area. Concentration of CO at each receptor site is computed separately. The 333 receptor sites are organized so that they form an array of grid size 2000 X 2000 feet. This receptor grid size is considered small enough to reveal the regional air quality impact as a whole as well as to identify problem areas or hot spots in microscale.

The APRAC-1A model described above was used for generating patterns of CO concentrations for the 1974 base year and for target year 1980 under no-build and build conditions. Input data consisted of the following:

- o CO emission rates calculated from VMT and corresponding emission factor data over 440 individual traffic links over the Red Line Extension study area
- o Meteorological data for wind, stability, and mixing height under (a) worst case situations, and (b) most probable case situations.

The computer output consisted of predicted values of carbon monoxide concentration in parts per million at each of the 333 grid point intersections shown in Figure 29. These values

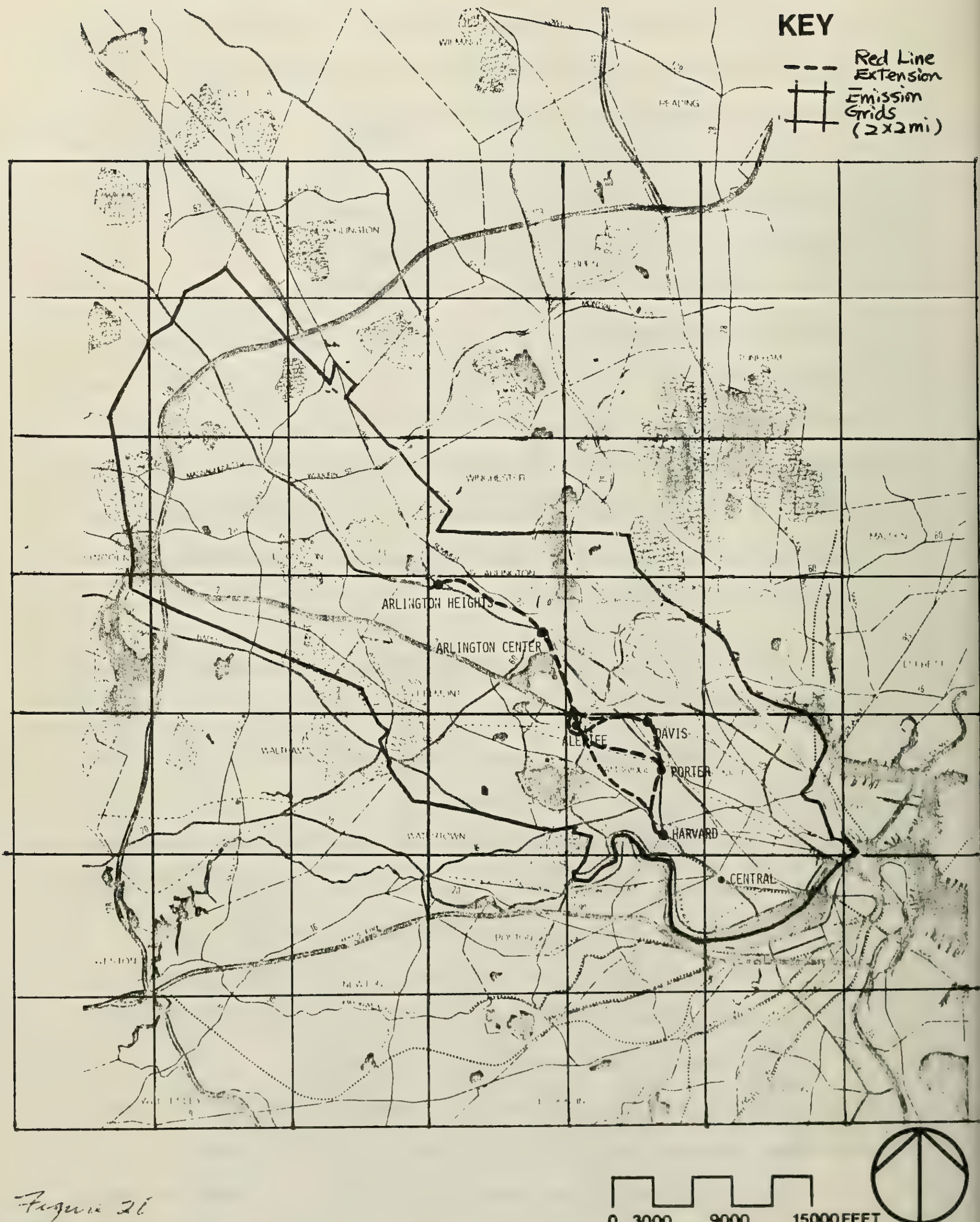


Figure 2l

~~Exhibit~~ Emission Grids for Air Quality Modeling

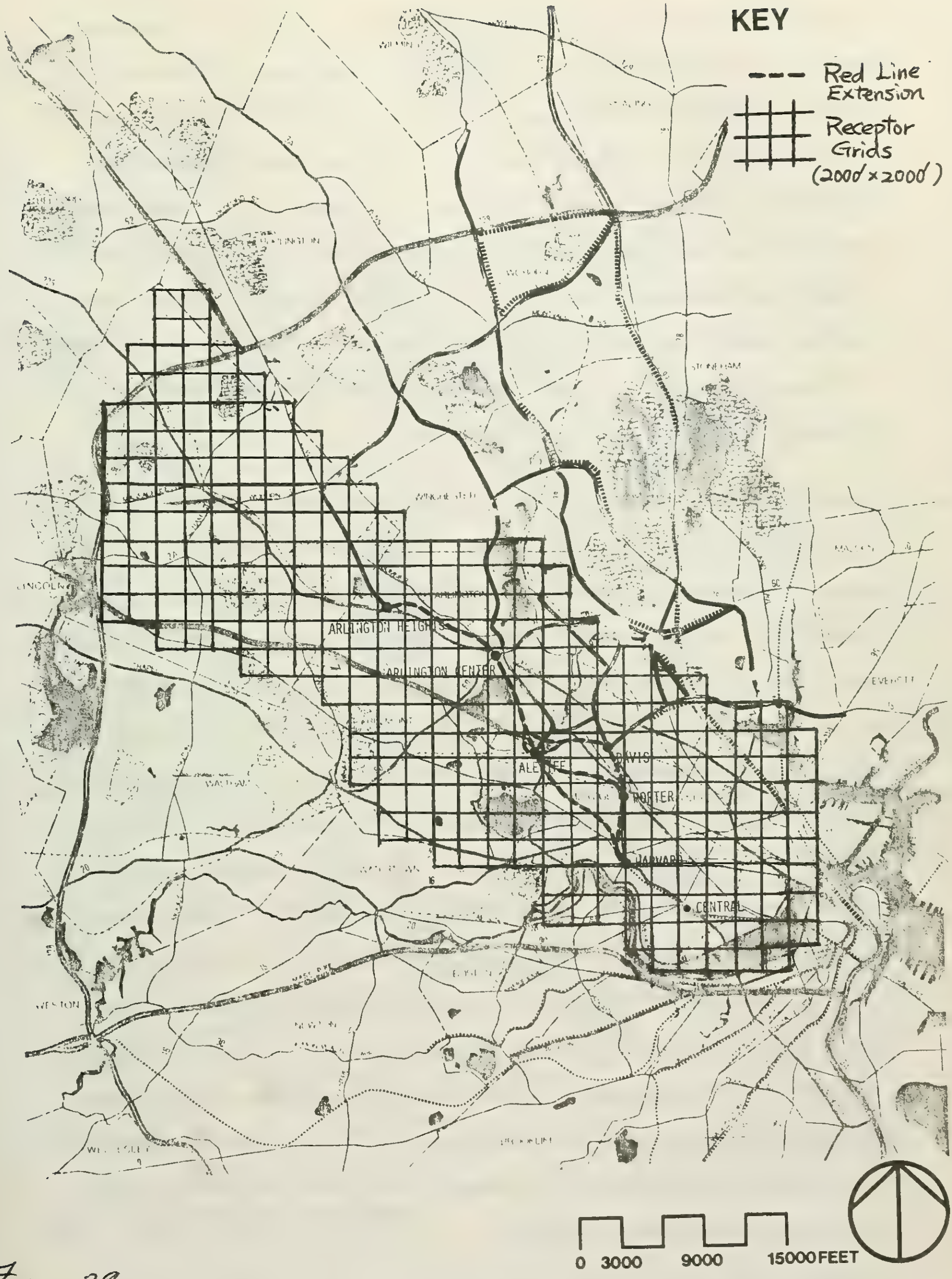


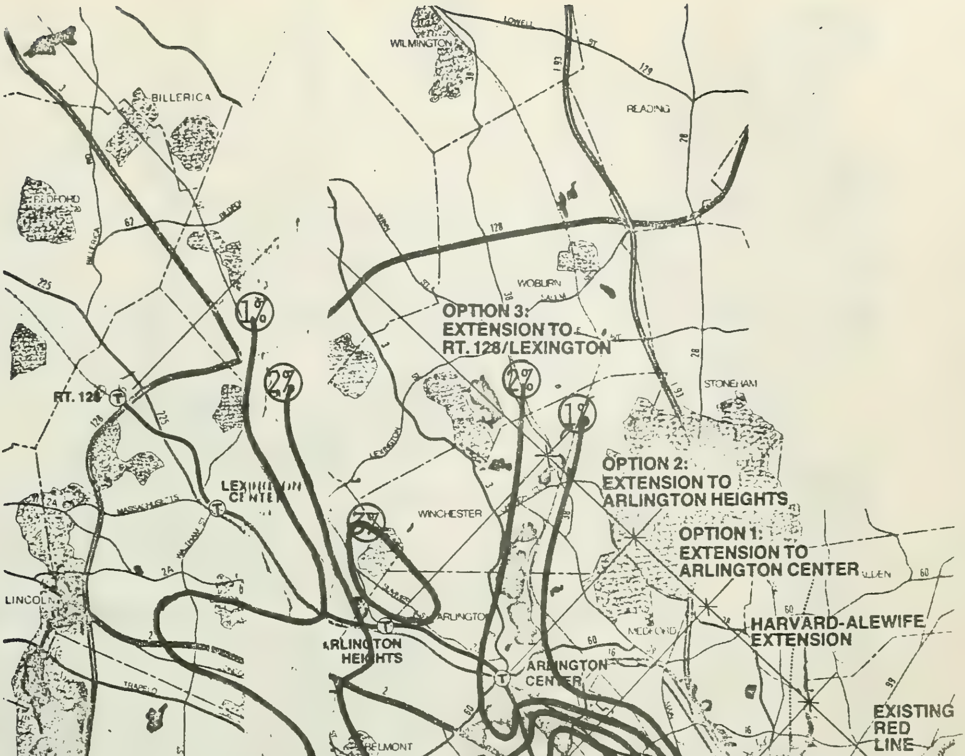
Figure 29
~~Exhibit~~ Receptor Grids for Air Quality Modeling

were entered onto an area base map and isopleths were drawn to show the pattern. The specific values were adjusted to conform with CO measurements reported for the Boston area in the GCA report (Reference 1). This adjustment step is referred to as model calibration (or "tuning"); it provides for realism and consistency between ground truth data and model predictions under simulated conditions. Projections on decreases in traffic due to auto diversions averaged over 24 hours and peak 8-hour and 1-hour periods are shown in Figures 30, 31, and 32, respectively.

E. AREAWIDE 1-HOUR AVERAGE CO CONCENTRATIONS

Figures 33, 34, and 35 show estimated patterns of carbon monoxide concentration at 1-hour peak traffic periods under worst-case meteorological conditions, for 1974, 1980 no-build, and 1980 build scenarios. The figures show that despite the slight anticipated increase in vehicular traffic between 1974 and 1980, a substantial reduction in CO concentrations should result if emission controls improve as expected. The projected reduction in CO emissions, shown by the July 1975 (fifth) supplement to the EPA document AP-42, "Compilation of Emission Factors", is from 67.5 g/mi to 31 g/mi.

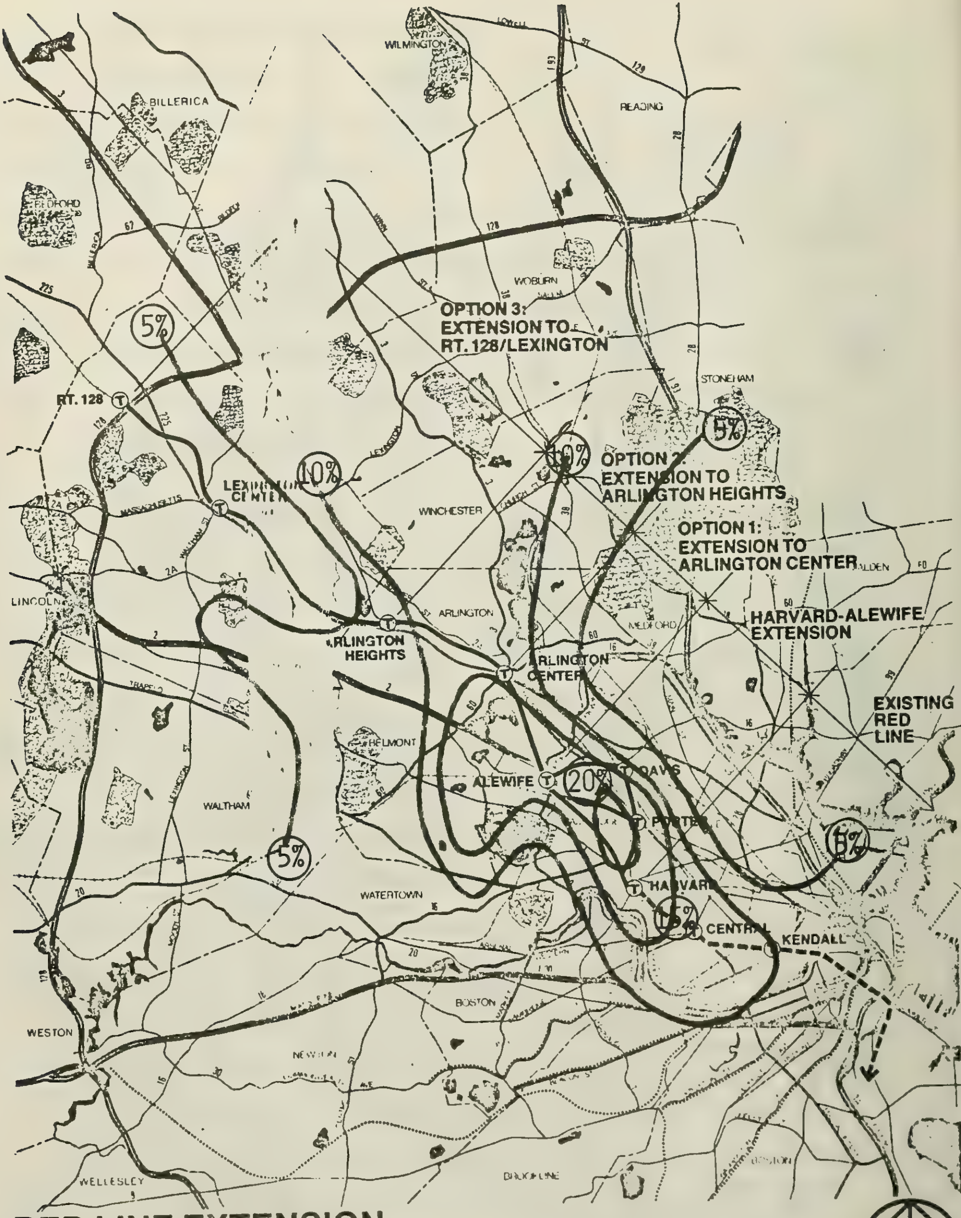
A further reduction in CO concentrations will result from the projected decrease in auto traffic after the transit system is in operation. This reduction will be significant in the Cambridge area but far less so in Lexington. At best, the decrease due to auto diversion will not match that due to improved emission control.



RED LINE EXTENSION

FIG. *30* 1980 BUILD CASE **NORTHWEST** 0 3000 9000 15000 FEET

PROJECTED DECREASE IN AVERAGE DAILY TRAFFIC DUE TO AUTO DIVERSIONS



RED LINE EXTENSION

FIG. 31 1980 BUILD CASE **NORTHWEST** 0 3000 9000 15000 FEET

PROJECTED DECREASE IN AVERAGE TRAFFIC OVER 8 CONSECUTIVE HOURS ABOUT THE PEAK PERIODS DUE TO AUTO DIVERSIONS

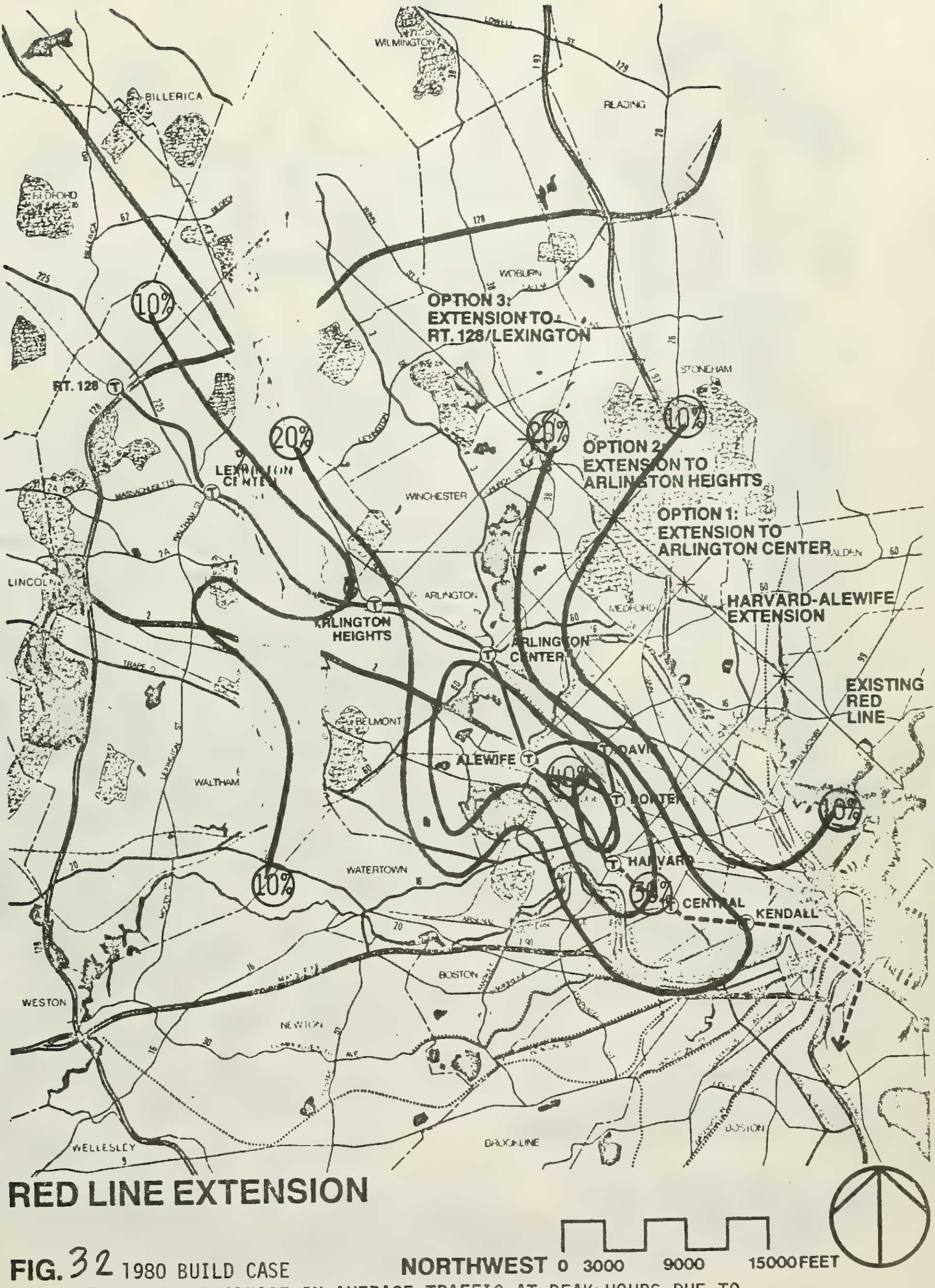


FIG. 32 1980 BUILD CASE

PROJECTED DECREASE IN AVERAGE TRAFFIC AT PEAK HOURS DUE TO AUTO DIVERSIONS

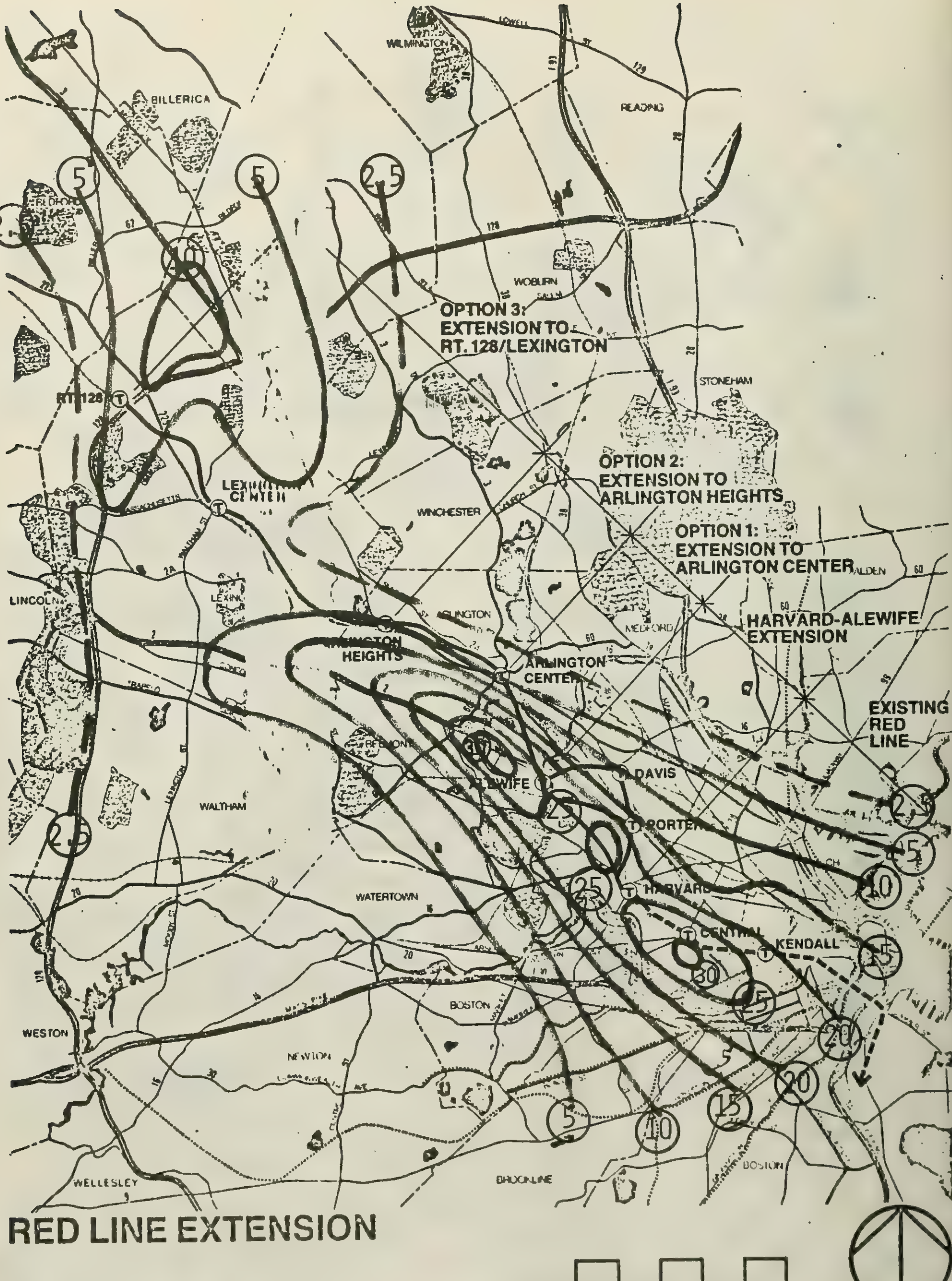
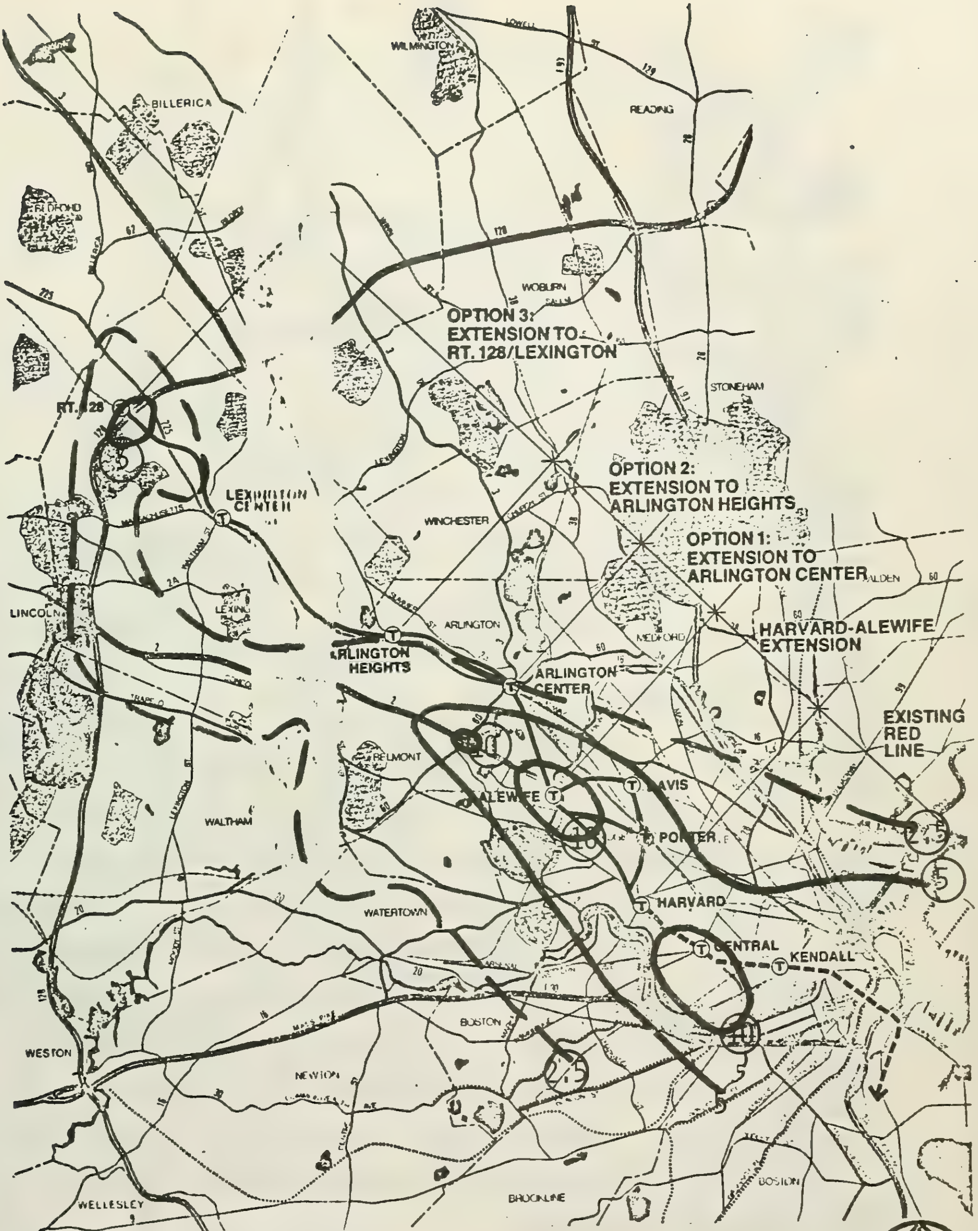


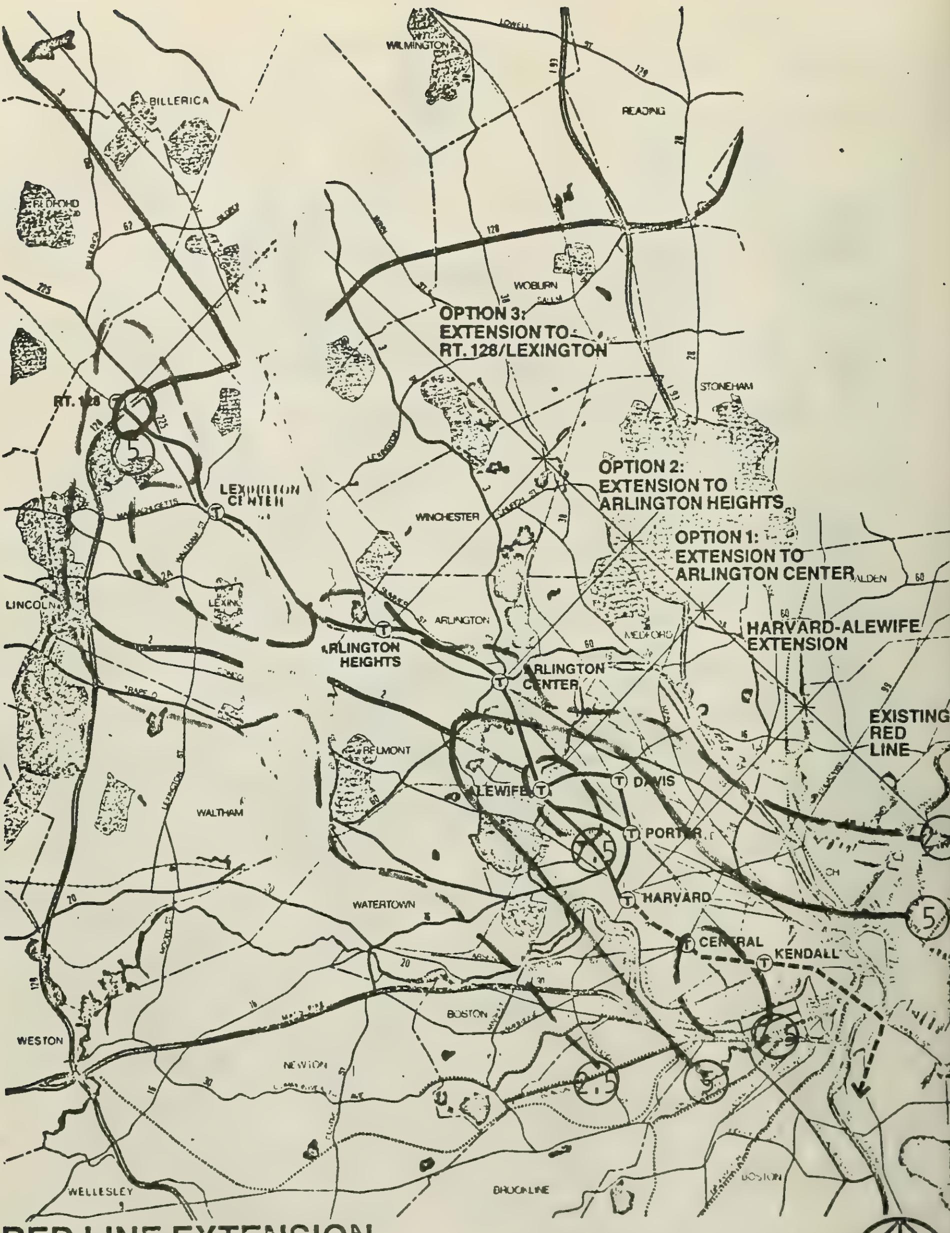
FIG. 33 1974 WORST CASE
1-HOUR AVERAGE CONCENTRATION OF CARBON MONOXIDE (ppm) ESTIMATED
VIA CALIBRATED APRAC-1A MODEL



RED LINE EXTENSION

NORTHWEST 0 3000 9000 15000 FEET

FIG. 34 1980 WORST CASE
1-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED
VIA CALIBRATED APRAC-1A MODEL: NO-BUILD CASE



RED LINE EXTENSION

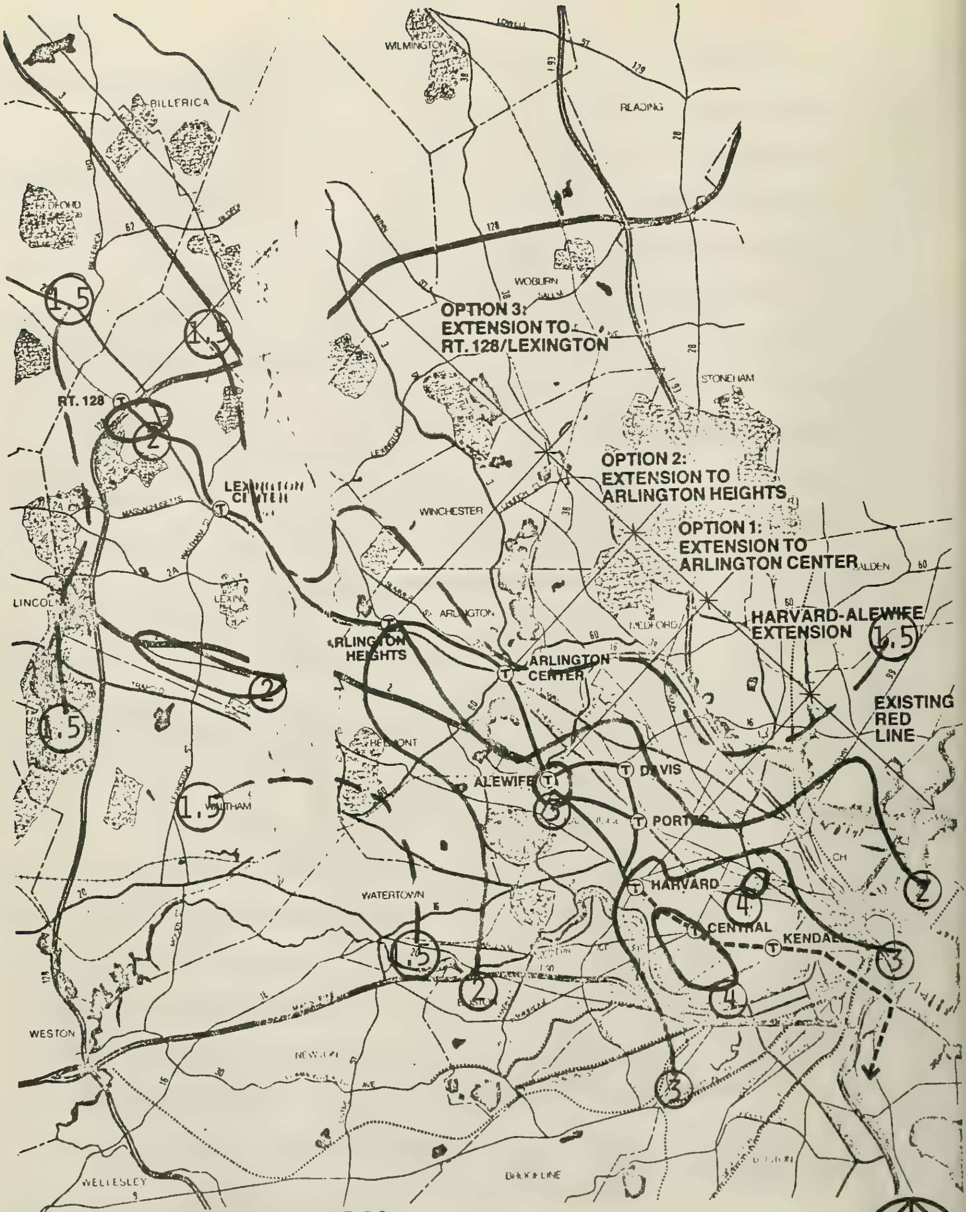
FIG. 35 1980 WORST CASE **NORTHWEST**
1-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED
VIA CALIBRATED APRAC-1A MODEL: BUILD CASE

In 1974 the estimated 1-hour peak concentrations of CO under worst conditions appear to be just under the EPA Air Quality Standard of 35 ppm. Emission controls, whether with or without project construction, will provide for compliance with the standard by a safe margin.

Figures 36 and 37 show the estimated patterns of 1-hour peak concentrations of CO under most probable meteorological conditions (wind WNW-11 mph, moderately stable lapse rate, average mixing height). The maximum concentrations of about 4 ppm in 1974 should be halved by 1980, and the additional reduction due to auto diversions in 1980 will be not be significant alongside the one-hour standard.

F. AREAWIDE 8-HOUR AVERAGE CO CONCENTRATIONS

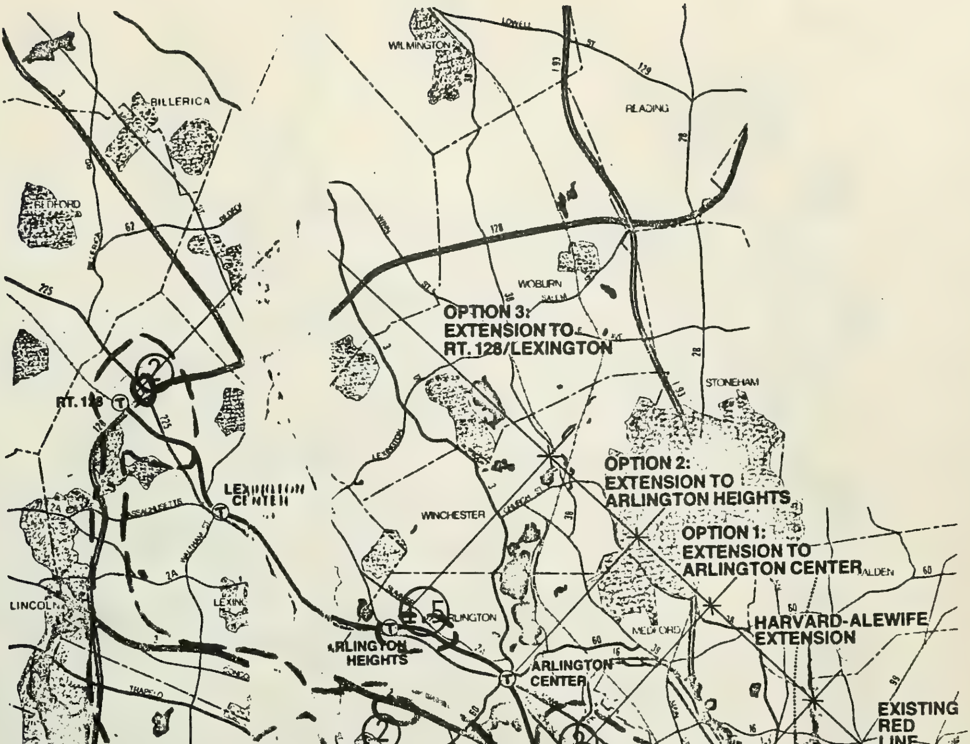
Figures 38 through 42 are analogous to the preceding set of five figures except that they apply to 8-hour average concentrations at peak traffic periods. However, the estimated 8-hour concentrations in 1974 under worst case meteorological conditions are shown to exceed 12 ppm, compared with the corresponding EPA standard of 9 ppm. Improved emission control by 1980 should lower the maximum concentrations, with pockets of 8 to 9 ppm remaining in the Cambridge area. Improvement to compliance by a more comfortable margin, with maxima at about 6 ppm, is expected to result from auto diversions following completion of the project.



RED LINE EXTENSION

NORTHWEST

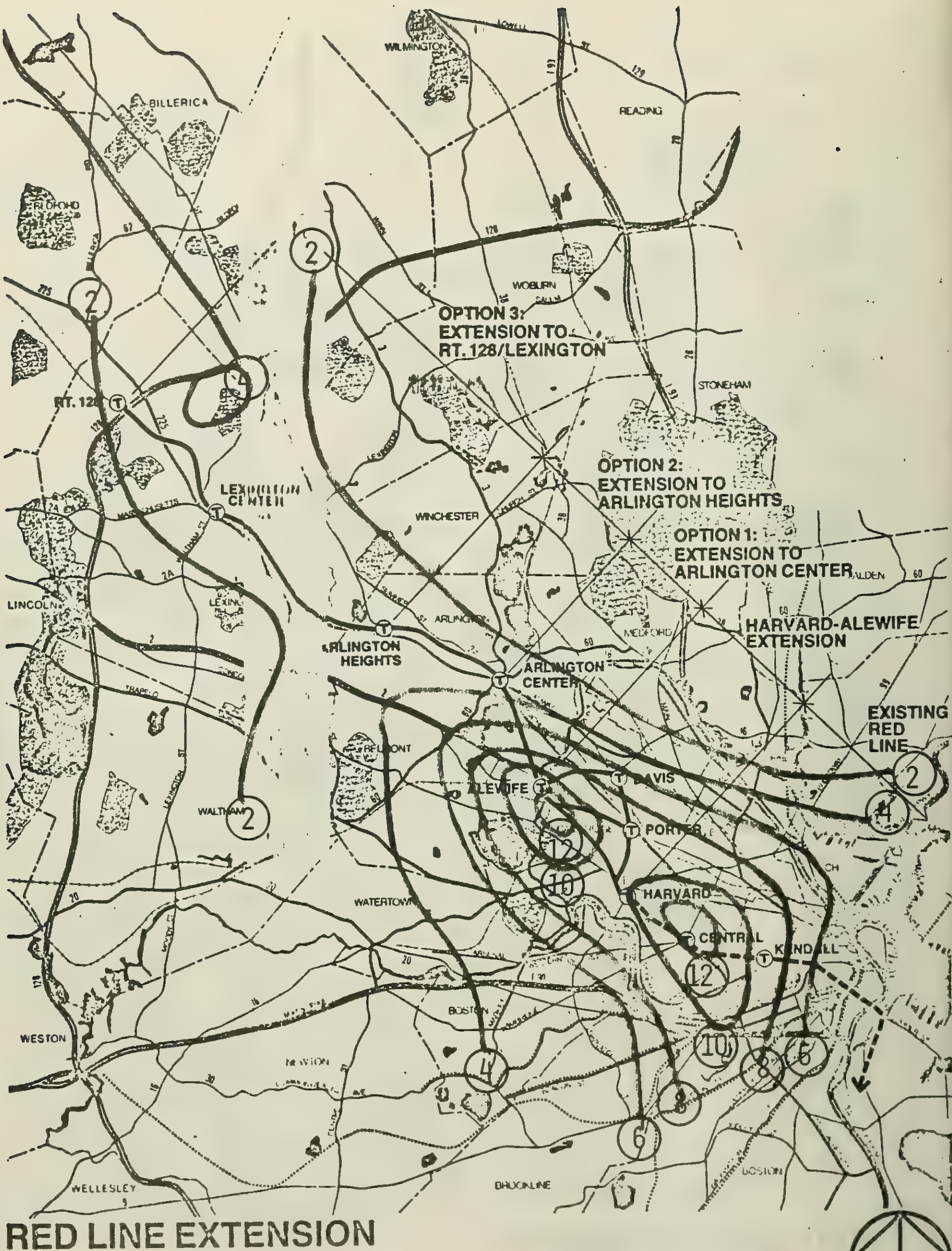
FIG. 36 1974 "MOST PROBABLE CASE"
1-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED
VIA CALIBRATED APRAC-1A MODEL



RED LINE EXTENSION

0 3000 9000 15000 FEET

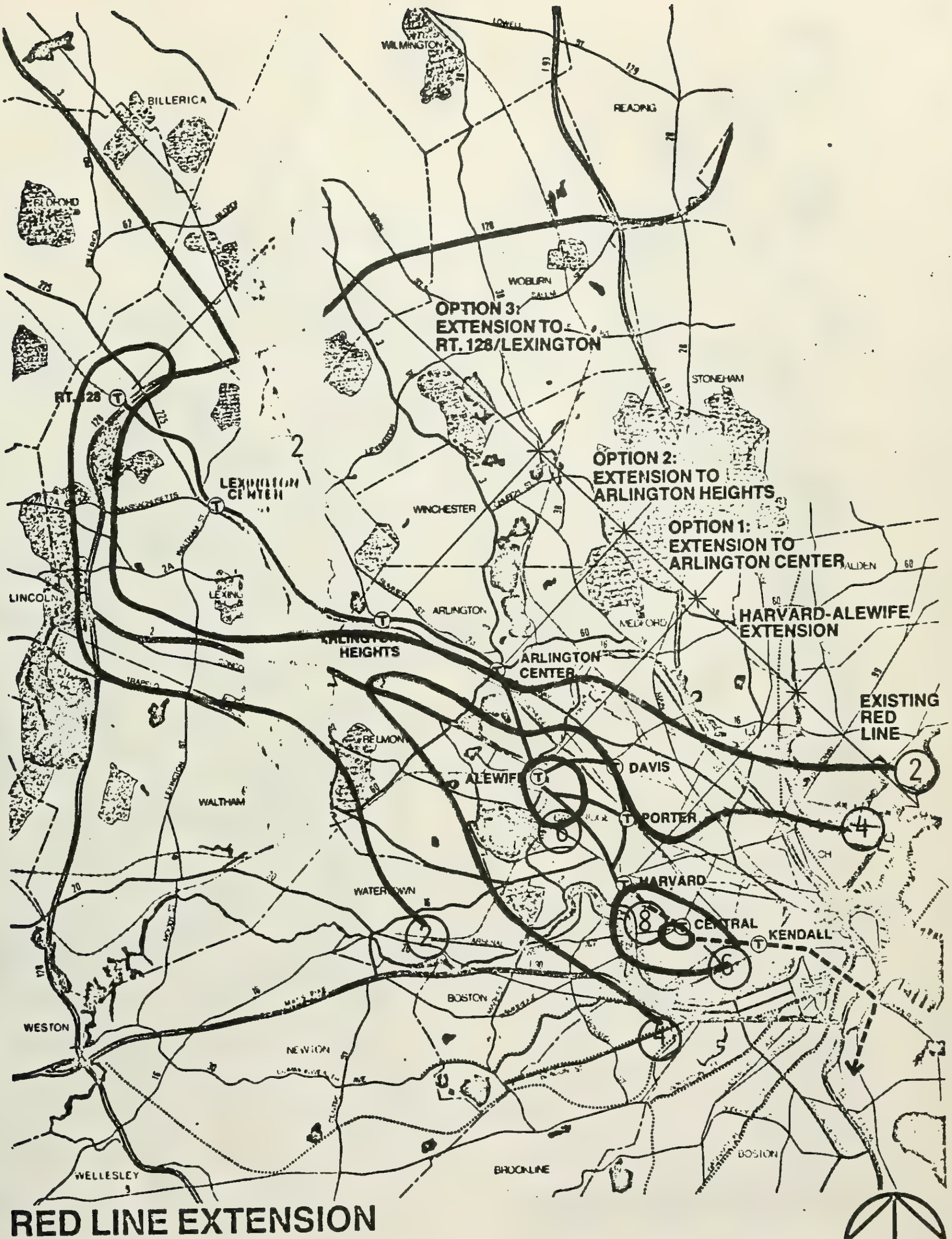
FIG. 37 1980 "MOST PROBABLE CASE" **NORTHWEST**
1-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED
VIA CALIBRATED APRAC-1A MODEL
NO-BUILD AND BUILD CASES



RED LINE EXTENSION

NORTHWEST 0 3000 9000 15000 FEET

FIG. 38 1974 WORST CASE 8-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED VIA CALIBRATED APRAC-1A MODEL



RED LINE EXTENSION

NORTHWEST 0 3000 9000 15000 FEET

FIG. 39 1980 WORST CASE
8-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED
VIA CALIBRATED APRAC-1A MODEL: NO-BUILD CASE

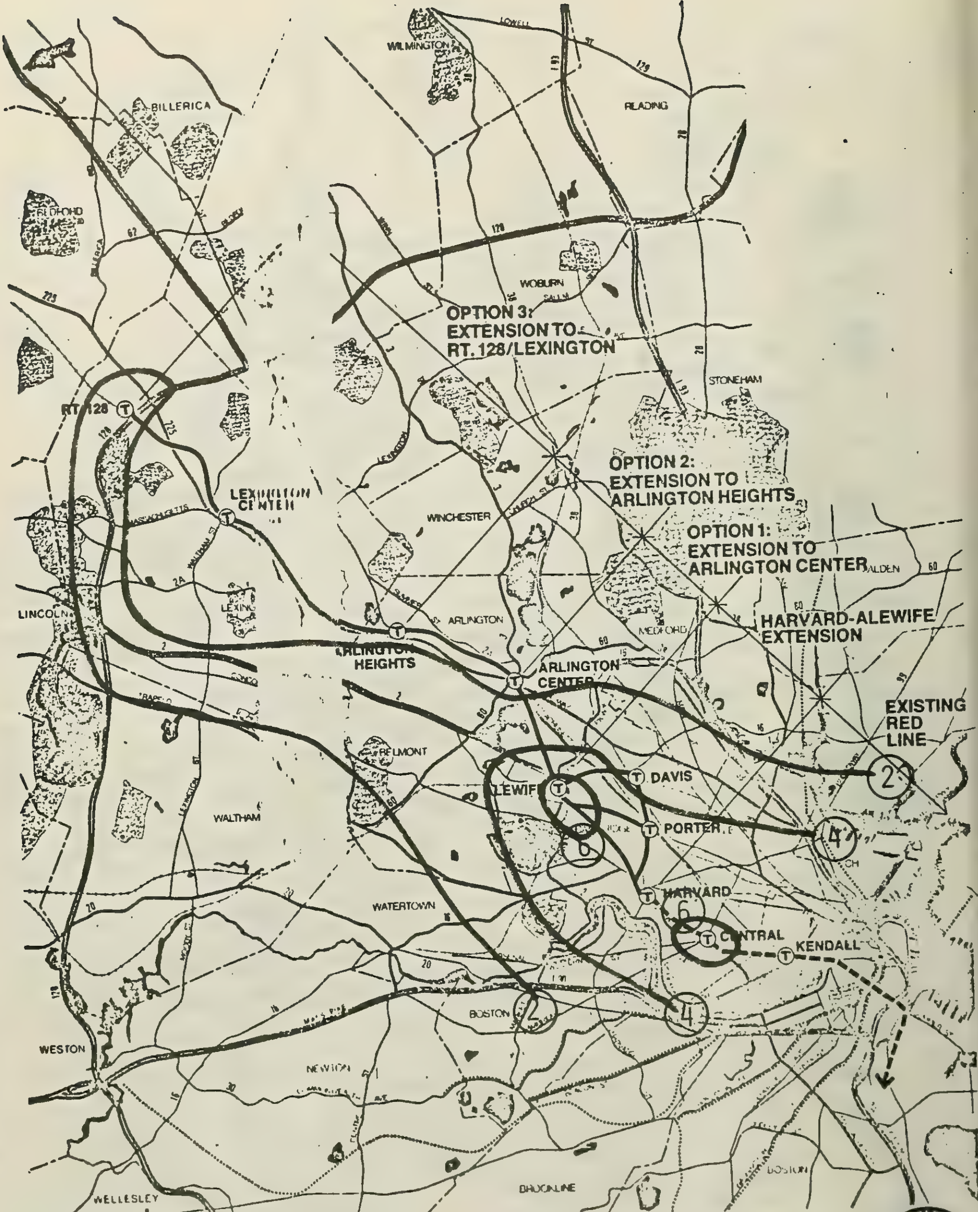
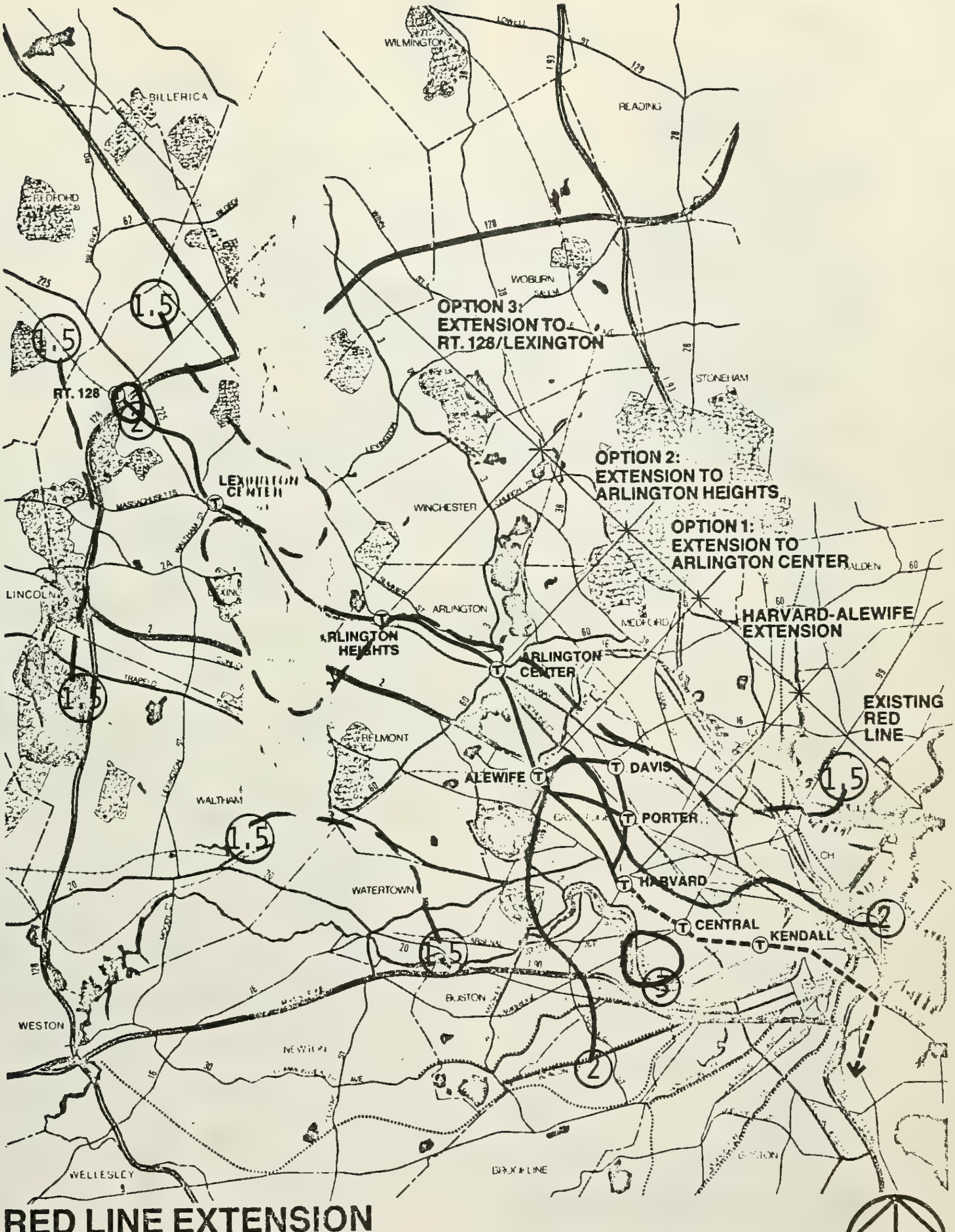


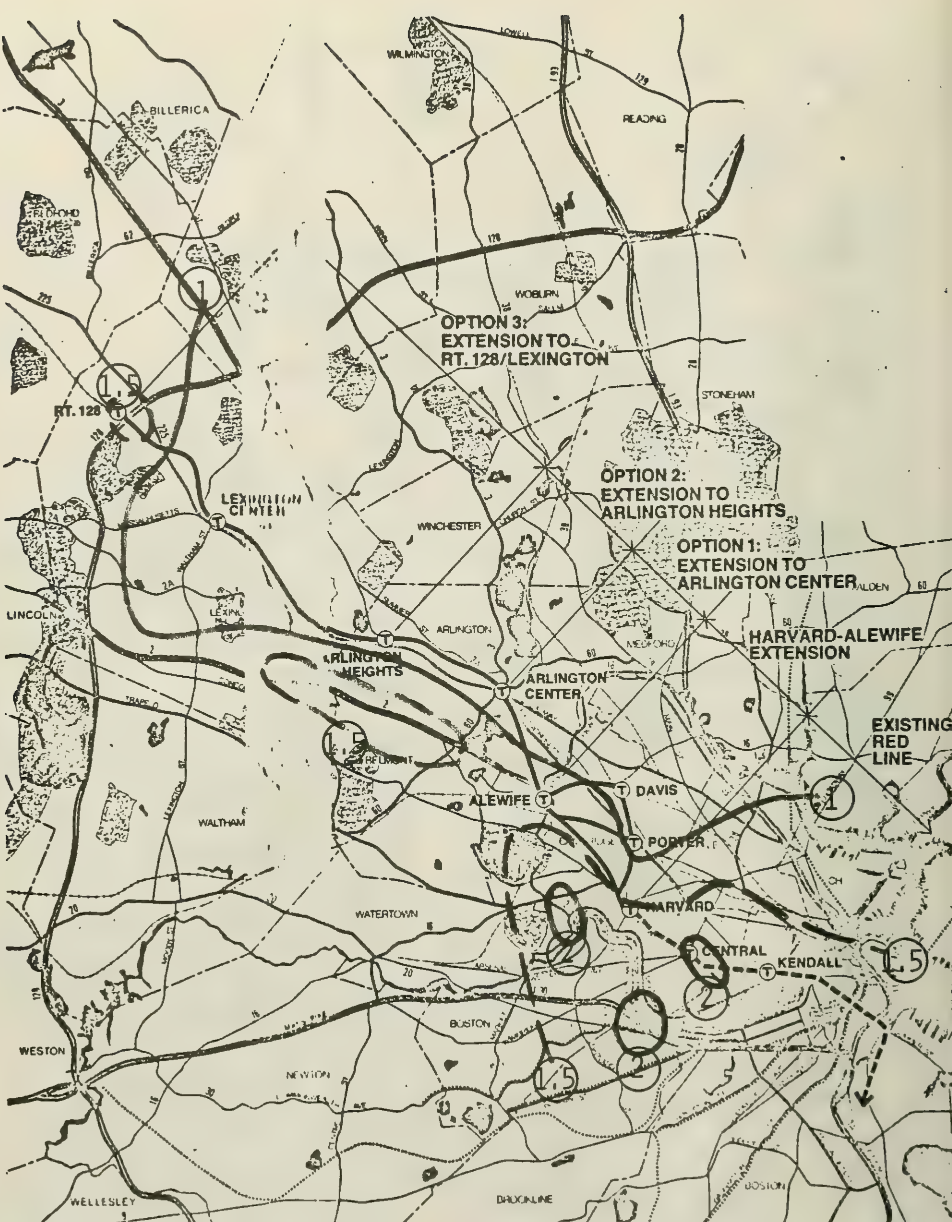
FIG. 40 1980 WORST CASE
8-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED
VIA CALIBRATED APRAC-1A MODEL: BUILD CASE



RED LINE EXTENSION

NORTHWEST 0 3000 9000 15000 FEET

FIG. 4/ 1974 "MOST PROBABLE CASE 8-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED VIA CALIBRATED APRAC-1A MODEL



RED LINE EXTENSION

FIG. 42 1980 MOST PROBABLE CASE **NORTHWEST** 0 3000 9000 15000 FEET
8-HOUR AVERAGE CONCENTRATIONS OF CARBON MONOXIDE (ppm) ESTIMATED VIA CALIBRATED APRAC-1A MODEL: NO-BUILD AND BUILD CASES

G. AREAWIDE SUMMARY

From the preceding modeling analysis we may conclude that:

- The greatest improvement in air quality over the area as a whole will result from more effective control of CO emissions from automotive vehicles.
- However, while the 1-hour EPA standard for CO will be met by emission control measures alone, compliance with the 8-hour standard by 1980 throughout all of Cambridge may be contingent upon construction of the Red Line Extension.

III. MICROSCALE ANALYSIS

A. ESTIMATES OF CO CONCENTRATIONS AT SPECIFIC STATIONS

Three alternative Red Line Extension termini were considered in estimating the CO concentrations at the proposed stations: Route 128, Arlington Heights, and Alewife. Proposed stations along the line are at the following locations:

- o Porter Square, at the intersection of Massachusetts and Somerville Avenues
- o Davis Square, at the junction of Elm Street, Highland Avenue, and Holland Street
- o Alewife Station, beneath Alewife Brook Parkway just south of the Fitchburg Freight Cutoff.
- o Arlington Center Station, beneath Massachusetts Avenue within the existing Boston and Maine Bedford Branch right-of-way.
- o Arlington Heights Station, within the Boston and Maine Bedford Branch right-of-way adjacent to the existing MBTA bus storage area on Massachusetts Avenue.

If the extension were not built at all, CO concentrations at the proposed stations could be estimated by interpolation of values shown in the preceding series of area-wide CO predictions. However, upon completion of the Extension, we may expect an increase of vehicles, mostly automobiles, in the vicinity of the stations. In addition to the normal through traffic, park-and-ride and kiss-and-ride vehicles would converge on the station areas at peak periods. The estimates on average daily traffic and

peak 8-hour and 1-hour traffic at each station are shown in the Appendix 3 series of tables. Each table lists traffic estimates for 1974, 1980 no-build, and 1980 build scenarios, along with corresponding emissions of carbon monoxide based on the EPA emission factors for the respective periods.

Methodology for Estimating CO Concentrations

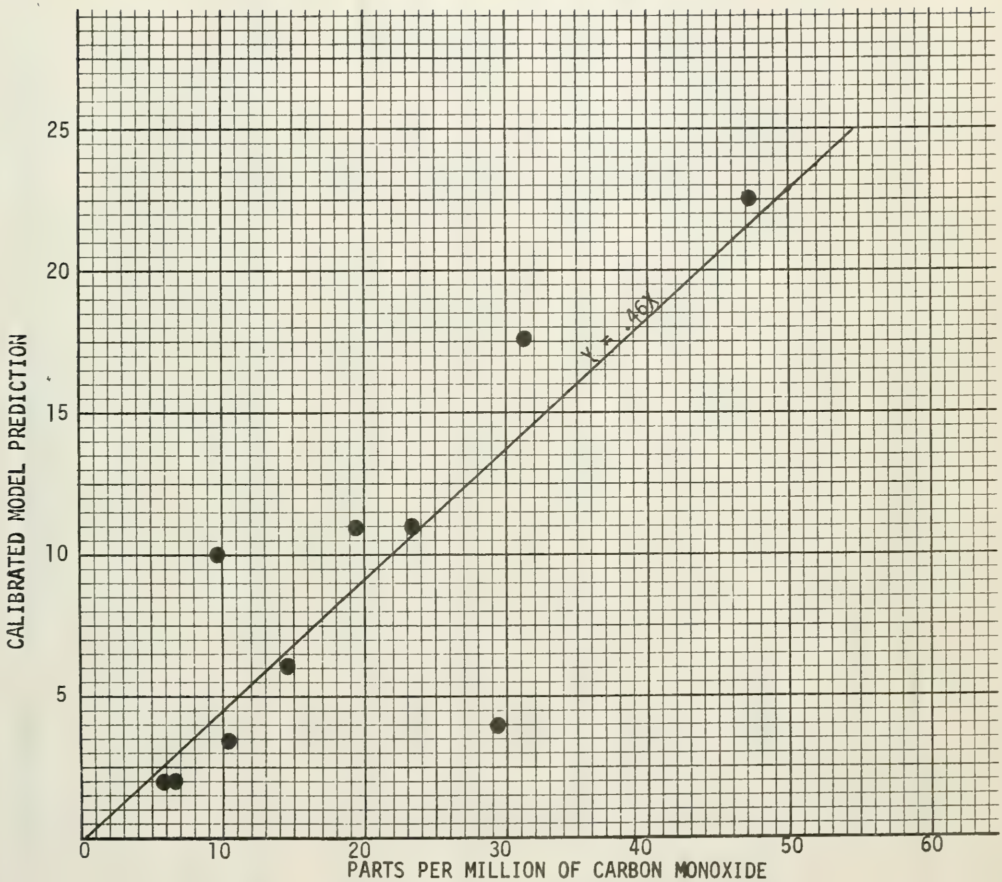
Atmospheric dispersion modeling was used for obtaining estimates of carbon monoxide concentrations in the station areas, based upon the meteorological conditions in "worst case" and "most probable" situations. For this microscale analysis, the worst case had to be defined for each station, which meant that a specific wind direction had to be used for advecting pollution from the heaviest flow of traffic only. Consideration of traffic downwind from the station were therefore excluded. For example, at Porter Square, the heaviest flow of traffic occurs on Massachusetts Avenue northwest of the designated station site. The worst case condition would include a one to three miles per hour wind from the northwest, F stability, and a low mixing height, say 300 meters for realism. Climatological data show that this condition could occur on the average of 2.0 hours per year. When it does, the traffic on Upland Road, White Street, Somerville Avenue, and Massachusetts Avenue south of the Square would not contribute measurably to CO concentrations at the station.

The actual mechanics of modeling was based on the application of one of the line source models shown in Turner's Workbook of Atmospheric Dispersion Estimates (Rev. 1969). Results were adjusted for consistency with areawide predictions generated by the APRAC-1A model by the use of a linear regression shown in Figure 43. The final predictions for the "build" cases in 1980 should not be the same as values interpolated from the corresponding areawide patterns because of the local maxima that will develop close to the five proposed stations. Because of the small area over which these maxima will occur, they will not often be discernible in area-size maps.

Modeling Results

Predictions of CO concentrations in the vicinity of the five stations are listed in Tables 8 through 12. As shown, estimates are given for the 1974, 1980 no-build, and 1980 build cases, with three alternative line termini under worst case and most probably meteorological conditions.

Results show the expected slight increases in CO concentrations for no-build and build cases during 1980. The highest concentrations are expected to be in the area of the Alewife Station, especially if the line terminates at that station. At all stations, 1-hour concentrations of CO are expected to be well under the EPA 1-hour



LINE SOURCE MODEL PREDICTION

Figure 43. Regression Curve of Calculated Carbon Monoxide Concentrations (ppm) via Line Source Model (Turner's Workbook) versus Calibrated APRAC-1A Model

Table 8. Predicted carbon monoxide concentrations (ppm) in the immediate vicinity of Specific Stations

Station: PORTER SQUARE

METEOROLOGICAL CONDITION	AVERAGING PERIOD	1974	1980: NO BUILD CASE	1980: BUILD CASE Termination at:		
				Route 128	Arlington Heights	Alewife
Worst Case	8 Hours	8.9	4.4	4.4	4.4	4.4
	1 Hour	14.4	7.1	7.1	7.1	7.1
Most Probable	8 Hours	1.9	1.0	1.0	1.0	1.0
	1 Hour	2.5	1.3	1.3	1.3	1.3

Table 9. Predicted carbon monoxide concentrations (ppm) in the immediate vicinity of Specific Stations

Station: DAVIS SQUARE

METEOROLOGICAL CONDITION	AVERAGING PERIOD	1974	1980: NO BUILD CASE	1980: BUILD CASE Termination at:		
				Route 128	Arlington Heights	Alewife
Worst Case	8 Hours	6.6	3.2	3.4	3.4	3.5
	1 Hour	10.7	5.2	5.5	5.5	5.6
Most Probable	8 Hours	1.6	0.8	0.9	0.9	0.9
	1 Hour	2.2	1.1	1.2	1.2	1.2

Table 10. Predicted carbon monoxide concentrations (ppm) in the immediate vicinity of Specific Stations

Station: ALEWIFE

METEOROLOGICAL CONDITION	AVERAGING PERIOD	1974	1980: NO BUILD CASE	1980: BUILD CASE Termination at:		
				Route 128	Arlington Heights	Alewife
Worst Case	8 Hours	13.5	6.6	6.8	6.8	6.9
	1 Hour	21.8	10.7	11.1	11.4	11.7
Most Probable	8 Hours	2.1	1.1	1.1	1.1	1.1
	1 Hour	3.3	1.7	1.8	1.8	1.9

Table 11. Predicted carbon monoxide concentrations (ppm) in the immediate vicinity of Specific Stations

Station: ARLINGTON CENTER

METEOROLOGICAL CONDITION	AVERAGING PERIOD	1974	1980: NO BUILD CASE	1980: BUILD CASE Termination at:		
				Route 128	Arlington Heights	Alewife
Worst Case	8 Hours	2.8	1.4	1.7	1.7	1.4
	1 Hour	4.5	2.3	3.0	3.0	2.3
Most Probable	8 Hours	1.6	0.8	0.8	0.8	0.8
	1 Hour	1.9	1.0	1.1	1.2	1.0

Table 12. Predicted carbon monoxide concentrations (ppm) in the immediate vicinity of Specific Stations

Station: ARLINGTON HEIGHTS

METEOROLOGICAL CONDITION	AVERAGING PERIOD	1974	1980: NO BUILD CASE	1980: BUILD CASE Termination at:		
				Route 128	Arlington Heights	Alewife
Worst Case	8 Hours	3.1	1.5	1.7	1.8	1.5
	1 Hour	4.8	2.5	3.1	3.2	2.5
Most Probable	8 Hours	1.4	0.6	0.6	0.6	0.6
	1 Hour	1.9	1.0	1.2	1.2	1.0

Ambient Air Quality Standard of 35 parts per million. 8-hour concentrations will also be in compliance with the respective standard, 9 parts per million, but the predicted value at the Alewife is only within 2 parts per million of the standard. However, the analysis shows that in 1974 the standard was probably exceeded several times during the year.

3. SUMMARY AND CONCLUSIONS

The foregoing analysis was based upon the use of atmospheric dispersion models in the absence of carbon monoxide concentration measurements within the area of interest. The predictions obtained by the application of models were made consistent with the measurements reported within the Boston area; the occurrence of maximum values at Kenmore Square offered a vantage point to which the model outputs could be adjusted.

Results of the analysis show that the reduction in pollutant emissions from vehicles in the forthcoming years will be more effective in reducing ambient CO concentrations than the construction of the Red Line Extension. In fact, the local increase in traffic near proposed stations once the line is in operation would tend to cause slight increases in CO levels were it not for the overriding effect of emission reduction. However, in the Cambridge area, where

most of the reduction in traffic due to auto diversions would be felt, this reduction would be vital for bringing the anticipated 1980 8-hour average to a condition of comfortable compliance. Without the construction of the Extension, the 8-hour standard, which is currently exceeded several times during the year, would still tend to be exceeded in 1980 though not as often as now.

APPENDIX 1

EPA NATIONAL AIR QUALITY STANDARDS

	National Primary Ambient Air Quality Standards	National Secondary Ambient Air Quality Standards
Particulate matter	(75$\mu g/m^3$ (annual geo. mean) (260$\mu g/m^3$ (max. 24 hour conc.)*	60$\mu g/m^3$(annual geo. mean) 150$\mu g/m^3$(max. 24 hour conc)*
SO_2	0.03 ppm (annual arith. mean) 0.14 ppm (max. 24 hour conc.)*	0.02 ppm (annual geo. mean) 0.1 ppm (max. 24 hour conc)* 0.5 ppm (max. 3 hour conc)*
NO_x	0.05 ppm (annual arith. mean)	same as primary standard
Hydrocarbons	0.24 ppm (Max. 3 hour conc. from 6:00 to 9: A.M.)*	same as primary standard
CO	9 ppm (max. 8 hour conc.)* 35 ppm (max. 1 hour conc.)*	same as primary standard same as primary standard
Photochemical oxidants	0.08 ppm (max. 1 hour conc.)*	same as primary standard

*Not to be exceeded more than once per year

APPENDIX 2

MASSACHUSETTS AIR QUALITY STANDARDS

Pollutant	Concentration
Total Suspended Particulates (TSP)	75 $\mu g/m^3$ (annual arithmetic mean) 180 $\mu g/m^3$ (24 hr. maximum average)*
Sulfur Oxides (SO_2)	0.025 ppm (annual arithmetic mean) 0.105 ppm (24 hr. maximum average)* 0.280 ppm (1 hr. maximum average)*
Nitrogen Oxides (NO_2)	none
Hydrocarbons	0.18 ppm (3 hr. maximum average)*
Carbon Monoxide (CO)	8 ppm (8 hr. maximum average)*
Photochemical Oxidants (O_3)	0.06 ppm (1 hr. maximum average)*

*Massachusetts standards are never to be exceeded.

APPENDIX 3

CARBON MONOXIDE COMPUTATIONAL WORKSHEETS FOR SPECIFIC STATIONS

The following tables show projections for traffic and associated average hourly emission rates of carbon monoxide at each of the five stations considered under the 1980 Build Case. The figures are listed by major arteries that feed traffic into the station area. Emission factors used to calculate emission rates from traffic flow are based on revised values given by Supplement #5 of AP-42, dated July 1975.

The basic figures provided by traffic engineers are the number of vehicles over a 24-hour period on each route. The numbers listed for 8-hour peak and 1-hour peak periods are estimated as follows:

- o The 1-hour peaks are assumed to be 10% of the average daily traffic
- o The 8-hour peaks are assumed to be 46% of the average daily traffic

The values listed under the column headed "Q" are average hourly emissions, expressed in miligrams per second (g/sec x 10^{-3}).

The use of an average hourly figure even in the 24-hour and 8-hour traffic cases is aimed at permitting direct comparison of 1-hour average concentrations regardless of the traffic period.

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Porter Sq

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak Camb. 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 1975) 1974: 67.5 g/mi .042 g/m 1980: 31 g/mi .0192 g/m

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	$(\frac{x}{10}^{-3})$ Q	[redacted] No.	Q x0.46	[redacted] No.	Q x0.46
Rte 128	Mass Ave (N)	39200	19.09	39796	~~19.28~~ 8.91	39796	~~19.38~~ 8.91
	Mass Ave (S)	20100	9.79	20406	~~9.94~~ 4.57	20396	~~9.93~~ 4.57
	Somerville Ave (E)	13065	6.36	13264	~~6.46~~ 2.97	13254	~~6.45~~ 2.97
	Upland Rd	6030	2.94	6122	~~2.98~~ 1.37	6112	~~2.98~~ 1.37
	White St	2010	0.98	2041	~~0.99~~ 0.46	2036	~~0.99~~ 0.46
Arlington Heights	Mass Ave (N)	39200	same	39796	same	39836	~~19.40~~ 8.92
	Mass Ave (S)	20100		20406		20496	~~9.98~~ 4.59
	Somerville Ave (E)	13065		13264		13344	~~6.5~~ 2.99
	Upland Rd	6030		6122		6232	~~3.03~~ 1.39
	White St	2010		2041		2061	~~1.00~~ 0.46
Alewife	Mass Ave (N)	39200	same	39796	same	39926	~~19.44~~ 8.94
	Mass Ave (S)	20100		20406		20676	~~10.07~~ 4.63
	Somerville Ave (E)	13065		13264		13524	~~6.59~~ 3.03
	Upland Rd	6030		6122		6402	~~3.12~~ 1.44
	White St	2010		2041		2171	~~1.06~~ 0.49

$0.46 = \frac{0.0192}{0.042}$

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Porter Sq.

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak / 8-Hr. Peak / 24-Hr. ADT ~~Cambr~~ Camb

EMISSION FACTORS (AP-42, Supp #5, 1975): 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	Q	[redacted] No.	Q	[redacted] No.	Q
Rte 128	Mass Ave (N)	19482	28.42	19779	~~28.86~~	19799	~~28.86~~
	Mass Ave (S)	9990	14.58	10142	~~14.80~~	10142	~~14.80~~
	Somerville Ave (E)	6493	9.47	6592	~~9.62~~	6592	~~9.62~~
	Upland Rd	2997	4.37	3043	~~4.44~~	3043	~~4.44~~
	White St	999	1.45	1014	~~1.48~~	1014	~~1.48~~
Arlington Hgts	Mass Ave (N)	19482	same	19779	same	19829	~~28.93~~
	Mass Ave (S)	9990		10142		10192	~~14.87~~
	Somerville Ave (E)	6493		6592		6642	~~9.69~~
	Upland Rd	2997		3043		3093	~~4.51~~
	White St	999		1014		1034	~~1.51~~
Alewife	Mass Ave (N)	19482	same	19779	same	19879	~~29.00~~
	Mass Ave (S)	9990		10142		10342	15.09
	Somerville Ave (E)	6493		6592		6742	~~9.84~~
	Upland Rd	2997		3043		3243	4.73
	White St	999		1014		1064	~~1.55~~

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Porter Sq Cambr.

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 10% ADT   8-Hr. Peak   24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 1975)
1974: 67.5 g/mi   1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974 No.	1974 10^{-3} Q	1980 (NB) No.	1980 (NB) Q ~~x 0.46~~	1980 (B) No.	1980 (B) Q ~~x 0.46~~
Rte 128	Mass Ave (N)	3920	45.79	3980	~~46.48~~ 21.38	3980	~~46.48~~ 21.3[illegible]
	Mass Ave (S)	2010	23.48	2041	~~23.84~~ 10.97	2041	~~23.84~~ 10.9[illegible]
	Somerville Ave (E)	1307	15.27	1327	~~15.50~~ 7.13	1327	~~15.50~~ 7.13
	Upland Rd	603	7.04	612	~~7.15~~ 3.29	612	~~7.15~~ 3.29
	White St	201	2.34	204	~~2.38~~ 0.94	204	~~2.38~~ 0.94
Arl. Heights	Mass Ave (N)	3920	same	3980	same	3990	~~46.60~~ 21.44
	Mass Ave (S)	2010		2041		2051	~~23.96~~ 11.02
	Somerville Ave (E)	1307		1327		1327	~~15.50~~ 7.13
	Upland Rd	603		612		622	~~7.26~~ 3.34
	White St	201		204		208	~~2.43~~ 1.12
Alewife	Mass Ave (N)	3920	same	3980	same	4000	~~46.72~~ 21.49
	Mass Ave (S)	2010		2041		2081	~~24.31~~ 11.18
	Somerville Ave (E)	1307		1327		1357	~~15.85~~ 7.29
	Upland Rd	603		612		652	~~7.62~~ 3.51
	White St	201		204		224	~~2.62~~ 1.21

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Davis Sq
Som

PERIOD: 1-HR. AVG BASED ON:
1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 1975
1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974 No.	1974 ($x10^{-3}$) Q	1980 (NB) No.	1980 (NB) Q	1980 (B) No.	1980 (B) Q
Rte 128	~~Elm St (NNW)~~	~~15051~~					
	Highland Ave	11037	5.38	11151	5.43	11641	5.67
	College Ave	18061	8.80	18247	8.89	18907	9.21
	Holland St (NNW)	15051	7.33	15206	7.41	15826	7.71
	Dover St	5017	2.44	5069	2.47	5459	2.66
	Day St	5017	2.44	5069	2.47	5459	2.66
	Elm St (SSE)	18061	8.80	18247	8.89	18737	9.21
Arlington Hts	Highland Ave	11037		11151		11711	5.70
	College Ave	18061		18247		18987	9.25
	Holland St	15051	same	15206	same	15906	7.75
	Dover St	5017		5069		5519	2.69
	Day St	5017		5069		5519	2.69
	Elm St	18061		18247		18707	9.[illegible]
Alewife	Highland Ave	11037		11851		11851	5.97
	College Ave	18061		18247		19167	9.33
	Holland St	15051	same	15206	same	16086	7.83
	Dover St	5017		5069		5619	2.74
	Day St	5017		5069		5619	2.74
	Elm St.	18061		18247		18949	9.23

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Davis Sq Som.

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 1975) 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974 No.	1974 Q	1980 (NB) No.	1980 (NB) Q	1980 (B) No.	1980 (B) Q
					~~x0.46~~		~~x0.46~~
Rte 128	Highland Ave	5485	8.00	5542	~~8.09~~ 3.72	5892	~~8.60~~ 3.96
	College Ave	8976	13.10	9069	~~13.23~~ 6.09	9519	~~13.89~~ 6.3[illegible]
	Holland St.	7480	10.91	7557	~~11.03~~ 5.07	4957	~~11.61~~ [illegible]
	Dover St	2493	3.64	2519	~~3.68~~ 1.[illegible]	2769	~~4.04~~ [illegible]
	Day St	2493	3.64	2519	~~3.68~~ [illegible]	2769	4.04
	Elm St	8976	13.10	9069	~~13.23~~ 6.0[illegible]	9419	~~13.94~~ [illegible]
Arlington Heights	Highland Ave	5485	same	5542	same	5942	~~8.67~~ [illegible]
	College Ave	8976		9069		9569	~~13.96~~ [illegible]
	Holland St	7480		7557		8007	~~11.68~~ [illegible]
	Dover St	2493		2519		2819	~~4.11~~ [illegible]
	Day St	2493		2519		2819	4.11
	Elm St	8976		9069		9469	~~13.82~~ 6.3[illegible]
Alewife	Highland Ave	5485	same	5542	same	5992	~~8.74~~ [illegible]
	College Ave	8976		9069		9719	~~14.18~~ 6.[illegible]
	Holland St	7480		7557		8157	~~11.90~~ [illegible]
	Dover St	2493		2519		2869	~~4.19~~ [illegible]
	Day St	2493		2519		2919	~~4.26~~ 1.96
	Elm St.	8976		9069		9519	~~13.89~~ 6.3[illegible]

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CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Davis Sq

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 19 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		No	$(\times 10^{-3})$ Q	No	Q	No.	Q
Rte 128	Highland Ave	1104	12.89	1115	13.02	1180	13.78
	College Ave	1806	21.09	1825	21.32	1915	22.3
	Holland St	1505	17.58	1521	17.77	1601	18.7
	Dover St	502	5.86	507	5.92	557	6.50
	Day St	502	5.86	507	5.92	557	6.50
	Elm St	1806	21.09	1825	21.32	1180	12.78
Arlington Hts	Highland Ave	1104		1115		1195	13.9
	College Ave	1806		1825		1925	22.4
	Holland St	1505	same	1521	same	1611	18.8
	Dover St	502		507		567	6.62
	Day St	502		507		567	6.62
	Elm St	1806		1825		1905	22.2
Alewife	Highland Ave	1104		1115		1205	14.0
	College Ave	1806		1825		1955	22.8
	Holland St	1505	same	1521	same	1641	19.1
	Dover St	502		507		577	6.7
	Day St	502		507		587	6.8
	Elm St	1806		1825		1915	22.3

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Alewife

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT Camb.

EMISSION FACTORS (AP-42, Supp #5, 1975) 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	$x10^{-3}$ Q	[redacted] No.	Q	[redacted] No.	Q
Rte 128	Alewife Pkwy (N)	59295	28.88	60196	29.32	61556	29.98
	Alewife Pkwy (S)	59295	28.88	60196	29.32	60636	29.53
	Rte 2 (W)	37592	18.31	39400	19.19	41810	20.36
	~~Rendge Ave~~	~~7035~~	~~–~~	~~7142~~			
Arlington Hts	Alewife Pkwy (N)	59295		60196		61596	30.00
	Alewife Pkwy (S)	59295		60196		60656	29.54
	Rte 2 (W)	37592	same	39400	same	42190	20.55
	Rendge Ave	~~7035~~		~~7142~~		—	
Alewife	Alewife Pkwy (N)	59295		60196		62416	30.40
	Alewife Pkwy (S)	59295		60196		60856	29.64
	Rte 2 (W)	37592	same	39400	same	43240	21.06
	~~Rendge Ave~~	~~7035~~		~~7142~~		—	

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Alewife

PERIOD: 1-HR. AVG BASED ON: 1-Hr Peak Camb 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 19
1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974 $(\times 10^3)$ No.	1974 Q	1980 (NB) No.	1980 (NB) Q	1980 (B) No.	1980 (B) Q
Rte 128	Alewife Pkwy (N)	29470	43.00	29917	~~43.65~~	30587	44.6
	Alewife Pkwy (S)	29470	43.00	29917	~~43.65~~	30137	43.9
	Rte 2 (W)	18683	27.26	19582	~~28.57~~	20787	30.3
	Rindge Ave	~~3496~~		3550	—	—	
Arlington Heights	Alewife Pkwy (N)	29470	same	29918	same	30617	44.6
	Alewife Pkwy (S)	29470		29917		30147	43.98
	Rte 2 (W)	18683		19582		23577	34.40
	Rindge Ave	~~3496~~		3550		—	
Alewife	Alewife Pkwy (N)	29470	same	29917	same	31027	45.2
	Alewife Pkwy (S)	29470		29917		30247	44.1
	Rte 2 (W)	18683		19582		21502	31 3
	Rindge Ave	3496		3550		—	

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Alewife Const.

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 1975) 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	Q	[redacted] No.	Q	[redacted] No.	Q
Rte 128	Alewife Pkwy (N)	5930	69.26	6020	x 0.46 ~~70.31~~	6270	x 0.46 ~~73.23~~
	Alewife Pkwy (S)	5930	69.26	6020	~~70.31~~	6090	~~71.13~~
	Rte 2 (W)	3759	43.90	3940	~~46.02~~ 21	4360	~~50.92~~
	Rindge Ave	~~704~~		~~714~~		—	
Arlington Hts	Alewife Pkwy (N)	5930	same	6020	same	6430	~~75.10~~
	Alewife Pkwy (S)	5930		6020		6120	~~71.48~~
	Rte 2 (W)	3759		3940		4750	~~55.48~~
	Rindge Ave	~~704~~		714		—	
Alewife	Alewife Pkwy (N)	5930	same	6020	same	6570	~~76.74~~
	Alewife Pkwy (S)	5930		6020		6160	~~71.95~~
	Rte 2 (W)	3759		3940		4920	~~57.47~~
	Rindge Ave	~~704~~		~~714~~		—	

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Arlington Ctr

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 19 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	Q	[redacted] No.	Q	[redacted] No.	Q
Rte 128	Mass Ave (E)	17272	8.41	18108	~~8.82~~	18428	8.97
	Mass Ave (W)	17272	8.41	18108	8.82	18648	9.08
	Mystic (N)	12192	5.94	12778	6.22	14898	7.26
	Pleasant St (S)	18288	8.91	19168	9.33	19408	9.45
Arlington Hts	Mass Ave (E)	17272	same	18108	same	18458	8.99
	Mass Ave (W)	17272		18108		18698	9.11
	Mystic (N)	12192		12778		15078	7.34
	Pleasant St (S)	18288		19168		19428	9.46
Alewife	Mass Ave (E)	17272	same	18108	same	18108	8.82
	Mass Ave (W)	17272		18108		18108	8.82
	Mystic (N)	12192		12778		12778	6.22
	Pleasant St (S)	18288		19168		19168	9.33

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Arlington Ctr

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 1975)
1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	$(\times 10^{-3})$ Q	[redacted] No.	Q	[redacted] No.	Q
Rte 128	Mass Ave (E)	8584	12.52	9000	13.13	9160	13.36
	Mass Ave (W)	8584	12.52	9000	13.13	9270	13.52
	Mystic (N)	6059	8.84	6351	9.27	7511	10.96
	Pleasant St (S)	9089	13.26	9526	13.90	9646	14.07
Arlington Hts	Mass Ave (E)	8584	same	9000	same	9175	13.39
	Mass Ave (W)	8584		9000		9295	13.56
	Mystic (N)	6059		6351		7501	10.94
	Pleasant St (S)	9089		9526		9656	14.09
Alewife	Mass Ave (E)	8584	same	9000	same	9000	13.13
	Mass Ave (W)	8584		9000		9000	13.13
	Mystic (N)	6059		6351		6351	9.27
	Pleasant St (S)	9089		9526		9526	13.90

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Arlington Ctr

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 19 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	$(\times 10^{-3})$ 1974		1980 (NB)		1980 (B)	
		[redacted] No.	Q	[redacted] No.	Q	[redacted] No.	Q
Rte 128	Mass Ave (E)	1727	20.17	1811	21.15	1861	21.74
	Mass Ave (W)	1727	20.17	1811	21.15	1911	22.32
	Mystic (N)	1219	14.24	1278	14.93	1688	19.72
	Pleasant St (S)	1829	21.36	1917	22.39	1957	22.86
Arlington Hts	Mass Ave (E)	1727	same	1811	same	1861	21.74
	Mass Ave (W)	1727		1811		1921	22.44
	Mystic (N)	1219		1278		1718	20.07
	Pleasant St (S)	1829		1917		1967	22.9
Alewife	Mass Ave (E)	1727	same	1811	same	1811	21.1
	Mass Ave (W	1727		1811		1811	21.1
	Mystic (N)	1219		1278		1278	14.9
	Pleasant St (S)	1829		1917		1917	22.3

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Arlington Hts

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 1975) 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	$(\times 10^{-3})$ Q	[redacted] No.	Q ~~x 0.49~~	[redacted] No.	Q ~~x 0.46~~
Rte 128	Mass Ave (W)	13208	6.43	13843	~~6.74~~	14603	~~7.11~~
	Mass Ave (E)	13208	6.43	13843	~~6.99~~	15543	7.57
Arlington Hts	Mass Ave (W)	13208	same	13843	same	14993	7.06
	Mass Ave (E)	13208		13843		16043	7.81
Alewife	Mass Ave (W)	13208	same	13843	same	13843	6.74
	Mass Ave (E)	13208		13843		13843	6.74

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Arlington Hts

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 19 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	($x10^{-3}$) Q	[redacted] No.	Q	[redacted] No.	Q
Rte. 128	Mass Ave (W)	6564	9.58	6880	10.04	7260	10.59
	Mass Ave (E)	6564	9.58	6880	10.04	7730	11.28
Arlington Hts	Mass Ave (W)	6564	same	6880	same	7555	11.02
	Mass Ave (E)	6564	same	6880	same	7990	11.66
Alewife	Mass Ave (W)	6564	same	6880	same	6880	10.04
	Mass Ave (E)	6564	same	6880	same	6880	10.04

CARBON MONOXIDE COMPUTATION: STATION SPECIFIC INPUT DATA

STATION: Arlington Hts

PERIOD: 1-HR. AVG BASED ON: 1-Hr. Peak 8-Hr. Peak 24-Hr. ADT

EMISSION FACTORS (AP-42, Supp #5, 1975) 1974: 67.5 g/mi 1980: 31 g/mi

ALTERNATIVE	THOROUGHFARES	1974		1980 (NB)		1980 (B)	
		[redacted] No.	$(x10^3)$ Q	[redacted] No.	Q	[redacted] No.	Q
Rte 128	Mass Ave (W)	1321	15.43	1384	~~16.17~~ 44	1524	~~17.80~~
	Mass Ave (E)	1321	15.43	1384	~~16.17~~ 7	1724	~~20.14~~
Arlington Hts	Mass Ave (W)	1321	same	1384	same	1594	~~18.62~~
	Mass Ave (E)	1321		1384		1794	~~20.95~~
Alewife	Mass Ave (W)	1321	same	1384	same	1384	~~16.17~~
	Mass Ave (E)	1321		1384		1384	~~16.17~~

APPENDIX I

CTPS MEMO ON RIDERSHIP FIGURES

Central Transportation Planning Staff
27 School St.
Boston, MA 02108

MEMORANDUM

TO: Jack G. Wofford July 2, 1975

FROM: Mike Jacobs

RE: Additional Data for Northwest Corridor Red Line Forecast

I am enclosing a series of tables reporting the revised 1980 Red Line Forecasts for the northwest corridor.

Tables 1 through 5 are identical to the comparable tables transmitted on 24 June 1975, and are included for the sake of completeness. Table 6 was also transmitted on June 24th, but contained an error; it has been revised for each of the three alternatives to reflect about another thousand 24-hour inbound kiss-riders boarding at Porter Square. Tables 7 through 13 contain additional detail pertinent to the forecasts, including constrained peak hour boardings and directions of access to Alewife station.

The attached Tables are as follows:

1. Estimated 1980 Peak Hour Inbound Boardings by Access Mode and Origin, Unconstrained by Parking Capacities--Alewife Terminus (2 sheets).
2. (Same as Table 1 for Arlington Heights Terminus) (3 sheets).
3. (Same as Table 1 for Route 128 Terminus) (4 sheets).
4. Summary of Estimated 1980 Peak Hour Unconstrained Boardings by Origin.
5. Summary of Estimated 1980 Inbound Boardings by Access Mode, Unconstrained by Parking Capacities.
6. Summary of Estimated 1980 Constrained 24-hour Inbound Boardings.
7. Park-Ride Arrivals--Alewife Terminus Scheme.
8. Park-Ride Arrivals--Arlington Heights Terminus Scheme (2 sheets)..
9. Park-Ride Arrivals--Route 128 Terminus Scheme (3 sheets).

10. Summary of Estimated 1980 Constrained Peak Hour Inbound Boardings.

11. Estimated Directions of Access for Peak Hour Trips to Alewife Station with Alewife Terminus.

12. (Same as Table 11 for Arlington Heights Terminus) (2 sheets).

12. (Same as Table 11 for Route 128 Terminus) (2 sheets).

MJ/jr

TABLE 1
ESTIMATED 1980 PEAK HOUR INBOUND BOARDINGS BY ACCESS MODE AND ORIGIN, UNCONSTRAINED BY PARKING CAPACITIES--ALEWIFE TERMINUS

ALTERNATIVE ALEWIFE
STATION NAME ALEWIFE

ORIGIN		PEAK HOUR INBOUND BOARDINGS				
NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
2	N. CAMBRIDGE	495	152	0	0	647
3	E. SOMERVILLE	0	0	0	4	4
4	W. SOMERVILLE	0	79	124	44	247
5	E. MEDFORD	0	12	0	47	59
6	W. MEDFORD	0	109	72	124	305
8	E. BELMONT	0	162	151	141	454
9	E. ARLINGTON	32	175	135	40	382
10	N. ARLINGTON	0	0	0	116	116
11	S. ARLINGTON	0	148	60	34	242
12	ARLINGTON CTR	0	16	8	30	54
13	W. BELMONT	0	83	62	217	362
14	W. ARLINGTON	0	67	0	68	135
15	NW. ARLINGTON	0	0	0	7	7
16	WALTHAM	0	32	0	90	122
17	W. WINCHESTER	0	64	0	152	216
19	E. LEXINGTON	0	0	0	19	19
20	S. LEXINGTON	0	0	0	29	29
21	S. WOBURN	0	0	0	13	13
22	S. LEXINGTON CTR	0	0	0	15	15
23	N. LEXINGTON CTR	0	0	0	21	21
25	S. BURLINGTON	0	0	0	36	36
26	BURLINGTON	0	0	0	36	36
27	NW. ARLINGTON	0	0	0	4	4
29	LINCOLN	0	0	0	48	48
30	BEDFORD	0	0	0	42	42
31	BILLERICA	0	0	0	90	90
32	CONCORD	0	0	0	80	80
33	OUTER NW.	0	0	0	105	105
	TOTALS	527	1099	612	1652	3890

TABLE 1 (CONTINUED)

ALEWIFE TERMINUS/INBOUND BOARDINGS BY MODE AND ORIGIN (CONT'D)

ALTERNATIVE: ALEWIFE
STATION NAME: DAVIS

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
2	N. CAMBRIDGE	177	0	125	0	302
3	E. SOMERVILLE	0	71	218	42	331
4	W. SOMERVILLE	530	472	45	10	1057
5	E. MEDFORD	0	66	144	96	306
6	W. MEDFORD	0	123	35	23	181
9	E. ARLINGTON	0	44	92	28	164
	OTHER	0	0	0	125	125
	TOTALS	707	776	659	324	2466

ALTERNATIVE: ALEWIFE
STATION NAME: PORTER

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
1	MID-CAMBRIDGE	255	0	192	48	495
2	N. CAMBRIDGE	192	610	32	8	842
3	E. SOMERVILLE	0	131	88	22	241
	CRR TRANSFERS					150
	TOTALS	447	741	312	78	1728

ALTERNATIVE: ALEWIFE
STATION NAME: HARVARD

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
1	MID-CAMBRIDGE	980	694	0	0	1674
2	N. CAMBRIDGE	20	100	30	0	150
7	WATERTOWN	0	630	0	0	630
8	E. BELMONT	0	530	0	0	530
	TOTALS	1000	1954	30	0	2984

TABLE 2

ESTIMATED 1980 PEAK HOUR INBOUND BOARDINGS BY ACCESS MODE AND ORIGIN, UNCONSTRAINED BY PARKING CAPACITIES--ARLINGTON HEIGHTS TERMINUS

ALTERNATIVE: ARLINGTON HEIGHTS
STATION NAME: ARLINGTON HEIGHTS

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
10	N. ARLINGTON	0	0	67	42	109
13	W. BELMONT	0	0	24	19	43
14	W. ARLINGTON	127	0	96	59	282
15	NW. ARLINGTON	47	0	18	16	81
16	WALTHAM	0	0	0	28	28
17	W. WINCHESTER	0	0	11	16	27
19	E. LEXINGTON	0	124	75	33	232
20	S. LEXINGTON	0	0	7	37	44
21	S. WOBURN	0	26	0	41	67
22	S. LEXINGTON CTR	0	24	4	17	45
23	N. LEXINGTON CTR	0	9	0	24	33
25	S. BURLINGTON	0	0	0	38	38
26	BURLINGTON	0	0	0	38	38
30	BEDFORD	0	55	0	48	103
32	CONCORD	0	0	0	43	43
33	OUTER NW.	0	0	0	43	43
	TOTALS	174	238	302	542	1256

ALTERNATIVE: ARLINGTON HEIGHTS
STATION NAME: ARLINGTON CTR.

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
5	E. MEDFORD	0	4	2	14	20
6	W. MEDFORD	0	55	85	176	316
8	E. BELMONT	0	25	22	43	90
9	E. ARLINGTON	67	0	41	62	170
10	N. ARLINGTON	159	0	156	196	511
11	S. ARLINGTON	126	110	0	0	236
12	ARLINGTON CTR	142	0	0	0	142
13	W. BELMONT	0	50	24	40	114
14	W. ARLINGTON	0	0	55	72	127
17	W. WINCHESTER	0	38	26	51	115
25	S. BURLINGTON	0	1	0	4	5
26	BURLINGTON	0	5	0	6	11
31	BILLERICA	0	0	0	45	45
33	OUTER NW.	0	0	0	2	2
	TOTALS	494	288	411	711	1904

TABLE 2 (CONTINUED)

ARLINGTON HTS TERM./INBOUND BOARDINGS BY MODE AND ORIGIN (CONT'D)

ALTERNATIVE: ARLINGTON HEIGHTS
STATION NAME: ALEWIFE

ORIGIN NO.	NAME	PEAK HOUR INBOUND BOARDINGS WALK	BUS	KISS	PARK	TOTAL
2	N. CAMBRIDGE	495	152	0	0	647
3	E. SOMERVILLE	0	0	0	4	4
4	W. SOMERVILLE	0	79	124	44	247
5	E. MEDFORD	0	0	0	41	41
6	W. MEDFORD	0	0	0	69	69
8	E. BELMONT	0	162	122	94	378
9	E. ARLINGTON	32	91	74	27	224
11	S. ARLINGTON	0	0	60	34	94
13	W. BELMONT	0	0	54	193	247
14	W. ARLINGTON	0	0	0	39	39
16	WALTHAM	0	32	0	68	100
17	W. WINCHESTER	0	0	0	102	102
20	S. LEXINGTON	0	0	0	6	6
27	NW. LEXINGTON	0	0	0	4	4
29	LINCOLN	0	0	0	48	48
31	BILLERICA	0	0	0	50	50
32	CONCORD	0	0	0	70	70
33	OUTER NW.	0	0	0	81	81
	TOTALS	527	516	434	974	2451

ALTERNATIVE: ARLINGTON HEIGHTS
STATION NAME: DAVIS

ORIGIN NO.	NAME	PEAK HOUR INBOUND BOARDINGS WALK	BUS	KISS	PARK	TOTAL
2	N. CAMBRIDGE	177	0	125	0	302
3	E. SOMERVILLE	0	71	218	42	331
4	W. SOMERVILLE	530	472	45	10	1057
5	E. MEDFORD	0	66	144	96	306
6	W. MEDFORD	0	123	35	23	181
9	E. ARLINGTON	0	44	92	28	164
	OTHER	0	0	0	125	125
	TOTALS	707	776	659	324	2466

TABLE 2 (CONTINUED)

ARLINGTON HTS TERM./INBOUND BOARDINGS BY MODE AND ORIGIN (CONT'D)

ALTERNATIVE: ARLINGTON HEIGHTS
STATION NAME: PORTER

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
1	MID-CAMBRIDGE	255	0	192	48	495
2	N. CAMBRIDGE	192	610	32	8	842
3	E. SOMERVILLE	0	131	88	22	241
	CRR TRANSFERS					150
	TOTALS	447	741	312	78	1728

ALTERNATIVE: ARLINGTON HEIGHTS
STATION NAME: HARVARD

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
1	MID-CAMBRIDGE	980	694	0	0	1674
2	N. CAMBRIDGE	20	100	30	0	150
7	WATERTOWN	0	630	0	0	630
8	E. BELMONT	0	530	0	0	530
	TOTALS	1000	1954	30	0	2984

TABLE 3

ESTIMATED 1980 PEAK HOUR INBOUND BOARDINGS BY ACCESS MODE AND ORIGIN, UNCONSTRAINED BY PARKING CAPACITIES--ROUTE 128 TERMINUS

ALTERNATIVE RT. 128
STATION NAME RT. 128

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
16	WALTHAM	0	0	0	24	24
20	S. LEXINGTON	0	0	0	10	10
21	S. WOBURN	0	0	0	13	13
23	N. LEXINGTON CTR	0	19	0	1	20
25	S. BURLINGTON	0	11	11	24	46
26	BURLINGTON	0	0	8	58	66
27	NW. LEXINGTON	93	11	12	6	122
29	LINCOLN	0	0	14	60	74
30	BEDFORD	0	0	8	99	107
31	BILLERICA	0	0	0	96	96
32	CONCORD	0	0	0	44	44
33	OUTER NW.	0	0	0	237	237
	OTHER	0	0	0	233	233
	TOTALS	93	41	53	905	1092

ALTERNATIVE RT. 128
STATION NAME LEXINGTON CTR

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
19	E. LEXINGTON	0	0	2	4	6
20	S. LEXINGTON	0	14	15	19	48
21	S. WOBURN	0	75	0	21	96
22	S. LEXINGTON CTR	39	38	17	12	106
23	N. LEXINGTON CTR	49	44	12	8	113
24	N. WOBURN	0	0	0	19	19
27	NW. LEXINGTON	0	0	0	2	2
28	SW. LEXINGTON	0	6	0	0	6
29	LINCOLN	0	7	0	5	12
30	BEDFORD	0	13	0	7	20
32	CONCORD	0	0	0	33	33
33	OUTER NW.	0	0	0	26	26
	OTHER	0	0	0	13	13
	TOTALS	88	197	46	169	500

TABLE 3 (CONTINUED)

ROUTE 128 TERMINUS/INBOUND BOARDINGS BY MODE AND ORIGIN (CONT'D)

ALTERNATIVE: RT. 128
STATION NAME: ARLINGTON HTS

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
10	N. ARLINGTON	0	0	67	42	109
13	W. BELMONT	0	0	24	19	43
14	W. ARLINGTON	127	0	96	59	282
15	NW. ARLINGTON	47	0	18	16	81
16	WALTHAM	0	0	0	15	15
17	W. WINCHESTER	0	0	11	16	27
19	E. LEXINGTON	0	116	50	63	229
20	S. LEXINGTON	0	0	3	16	19
21	S. WOBURN	0	24	0	37	61
23	N. LEXINGTON	0	4	1	6	11
25	S. BURLINGTON	0	0	0	15	15
32	CONCORD	0	0	0	8	8
	TOTALS	174	144	270	312	900

ALTERNATIVE: RT. 128
STATION NAME: ARLINGTON CTR

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
5	E. MEDFORD	0	4	2	14	20
6	W. MEDFORD	0	55	85	176	316
8	E. BELMONT	0	25	22	43	90
9	E. ARLINGTON	67	0	41	62	170
10	N. ARLINGTON	159	0	156	196	511
11	S. ARLINGTON	126	110	0	0	236
12	ARLINGTON CTR	142	0	0	0	142
13	W. BELMONT	0	50	24	40	114
14	W. ARLINGTON	0	0	55	72	127
17	W. WINCHESTER	0	38	26	51	115
25	S. BURLINGTON	0	1	0	4	5
26	BURLINGTON	0	5	0	3	8
31	BILLERICA	0	0	0	35	35
33	OUTER NW.	0	0	0	2	2
	TOTALS	494	288	411	698	1891

TABLE 3 (CONTINUED)

ROUTE 128 TERMINUS/INBOUND BOARDINGS BY MODE AND ORIGIN (CONT'D)

ALTERNATIVE RT. 128

STATION NAME ALEWIFE

ORIGIN NO.	NAME	PEAK HOUR INBOUND BOARDINGS WALK	BUS	KISS	PARK	TOTAL
2	N. CAMBRIDGE	495	152	0	0	647
3	E. SOMERVILLE	0	0	0	4	4
4	W. SOMERVILLE	0	79	124	44	247
5	E. MEDFORD	0	0	0	41	41
6	W. MEDFORD	0	0	0	69	69
8	E. BELMONT	0	162	122	94	378
9	E. ARLINGTON	32	91	74	27	224
11	S. ARLINGTON	0	0	60	34	94
13	W. BELMONT	0	0	54	193	247
14	W. ARLINGTON	0	0	0	39	39
16	WALTHAM	0	32	0	68	100
17	W. WINCHESTER	0	0	0	102	102
29	LINCOLN	0	0	0	15	15
32	CONCORD	0	0	0	42	42
33	OUTER NW.	0	0	0	24	24
	TOTALS	527	516	434	796	2273

ALTERNATIVE RT. 128

STATION NAME DAVIS

ORIGIN NO.	NAME	PEAK HOUR INBOUND BOARDINGS WALK	BUS	KISS	PARK	TOTAL
2	N. CAMBRIDGE	177	0	125	0	302
3	E. SOMERVILLE	0	71	218	42	331
4	W. SOMERVILLE	530	472	45	10	1057
5	E. MEDFORD	0	66	144	96	306
6	W. MEDFORD	0	123	35	23	181
9	E. ARLINGTON	0	44	92	28	164
	OTHER	0	0	0	125	125
	TOTALS	707	776	659	324	2466

TABLE 3 (CONTINUED)

ROUTE 128 TERMINUS/INBOUND BOARDINGS BY MODE AND ORIGIN (CONT'D)

ALTERNATIVE RT. 128

STATION NAME PORTER

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
1	MID-CAMBRIDGE	255	0	192	48	495
2	N. CAMBRIDGE	192	610	32	8	842
3	E. SOMERVILLE	0	131	88	22	241
	CRR TRANSFERS					150
	TOTALS	447	741	312	78	1728

ALTERNATIVE RT. 128

STATION NAME HARVARD

ORIGIN NO.	NAME	WALK	BUS	KISS	PARK	TOTAL
		PEAK HOUR INBOUND BOARDINGS				
1	MID-CAMBRIDGE	980	694	0	0	1674
2	N. CAMBRIDGE	20	100	30	0	150
7	WATERTOWN	0	630	0	0	630
8	E. BELMONT	0	530	0	0	530
	TOTALS	1000	1954	30	0	2984

TABLE 4

SUMMARY OF ESTIMATED 1980 PEAK HOUR UNCONSTRAINED BOARDINGS BY ORIGIN

ORIGIN NO.	NAME	TOTAL PEAK HOUR INBOUND BOARDINGS WITH TERMINUS AT ALEWIFE	ARLING-TON HTS	ROUTE 128
1	MID-CAMBRIDGE	2169	2169	2169
2	N. CAMBRIDGE	1941	1941	1941
3	E. SOMERVILLE	576	576	576
4	W. SOMERVILLE	1304	1253	1253
5	E. MEDFORD	365	367	367
6	W. MEDFORD	486	566	566
7	WATERTOWN	630	630	630
8	E. BELMONT	984	998	998
9	E. ARLINGTON	546	558	558
10	N. ARLINGTON	116	620	620
11	S. ARLINGTON	242	330	330
12	ARLINGTON CTR	54	142	142
13	W. BELMONT	362	404	404
14	W. ARLINGTON	135	448	448
15	NW. ARLINGTON	7	81	81
16	WALTHAM	122	128	139
17	W. WINCHESTER	216	244	244
19	E. LEXINGTON	19	232	235
20	S. LEXINGTON	29	50	77
21	S. WOBURN	13	67	170
22	S. LEXINGTON CTR	15	45	106
23	N. LEXINGTON CTR	21	33	144
24	N. WOBURN	0	0	19
25	S. BURLINGTON	36	43	66
26	BURLINGTON	36	49	74
27	NW. LEXINGTON	4	4	124
28	SW. LEXINGTON	0	0	6
29	LINCOLN	48	48	101
30	BEDFORD	42	103	127
31	BILLERICA	90	95	131
32	CONCORD	80	113	127
33	OUTER NW.	105	126	289
	OTHER	125	125	371
	CRR TRANSFERS	150	150	150
	TOTALS	11068	12789	13834

TABLE 5
SUMMARY OF ESTIMATED 1980 INBOUND BOARDINGS BY ACCESS MODE, UNCONSTRAINED BY PARKING CAPACITIES

ALEWIFE TERMINUS SCHEME

STATION	PEAK HOUR INBOUND BOARDINGS WALK	BUS	KISS	PARK	TOTAL	TOTAL 24-HOUR INBOUND BOARDINGS
ALEWIFE	527	1099	612	1652	3890	14461
DAVIS	707	776	659	324	2466	9167
PORTER	447	741	312	78	1728	6424
HARVARD	1000	1954	30	0	2984	11093
TOTALS	2681	4570	1613	2054	11068	41145

ARLINGTON HEIGHTS TERMINUS SCHEME

STATION	PEAK HOUR INBOUND BOARDINGS WALK	BUS	KISS	PARK	TOTAL	TOTAL 24-HOUR INBOUND BOARDINGS
ARLINGTON HEIGHTS	174	238	302	542	1256	4669
ARLINGTON CENTER	494	288	411	711	1904	7078
ALEWIFE	527	516	434	974	2451	9112
DAVIS	707	776	659	324	2466	9167
PORTER	447	741	312	78	1728	6424
HARVARD	1000	1954	30	0	2984	11093
TOTALS	3349	4513	2148	2629	12789	47543

ROUTE 128 TERMINUS SCHEME

STATION	PEAK HOUR INBOUND BOARDINGS WALK	BUS	KISS	PARK	TOTAL	TOTAL 24-HOUR INBOUND BOARDINGS
ROUTE 128	93	41	53	905	1092	4059
LEXINGTON CENTER	88	197	46	169	500	1859
ARLINGTON HEIGHTS	174	144	270	312	900	3346
ARLINGTON CENTER	494	288	411	698	1891	7030
ALEWIFE	527	516	434	796	2273	8450
DAVIS	707	776	659	324	2466	9167
PORTER	447	741	312	78	1728	6424
HARVARD	1000	1954	30	0	2984	11093
TOTALS	3530	4657	2215	3282	13834	51428

NOTE--TOTAL PEAK HOUR BOARDINGS AT PORTER INCLUDE 150 PERSONS TRANSFERING FROM COMMUTER RAIL (ALL ALTERNATIVES).

TABLE 6

SUMMARY OF ESTIMATED 1980 CONSTRAINED 24-HOUR INBOUND BOARDINGS

STATION	ASSUMED PARKING SPACES	24-HOUR INBOUND BOARDINGS (PERSONS) WALK	BUS	KISS	PARK	TOTAL	PK-HR PARK-RIDERS
ALEWIFE TERMINUS SCHEME							
ALEWIFE	2000	1959	4629	2637	2520	11745	1603
DAVIS	0	2628	2945	2510	0	8083	0
PORTER	0	1662	2784	1189	0	6193	0
HARVARD	0	3717	7264	112	0	11093	0
TOTAL	2000	9966	17622	6448	2520	37114	1603
ARLINGTON HEIGHTS TERMINUS SCHEME							
ARLINGTON HTS	350	647	1121	1359	441	3568	317
ARLINGTON CTR	350	1836	1401	1748	441	5426	345
ALEWIFE	2000	1959	2138	1723	2520	8340	1510
SUBTOTAL	2700	4442	4660	4830	3402	17334	2172
DAVIS	0	2628	2945	2510	0	8083	0
PORTER	0	1662	2784	1189	0	6193	0
HARVARD	0	3717	7264	112	0	11093	0
TOTAL	2700	12449	17653	8641	3402	42703	2172
ROUTE 128 TERMINUS SCHEME							
ROUTE 128	2000	346	152	197	2520	3215	905
LEXINGTON CTR	300	327	748	196	378	1649	181
ARLINGTON HTS	350	647	643	1112	441	2843	297
ARLINGTON CTR	350	1836	1394	1743	441	5414	343
ALEWIFE	2000	1959	2070	1657	2520	8206	1181
SUBTOTAL	5000	5115	5007	4905	6300	21327	2907
DAVIS	0	2628	2945	2510	0	8083	0
PORTER	0	1662	2784	1189	0	6193	0
HARVARD	0	3717	7264	112	0	11093	0
TOTAL	5000	13122	18000	8716	6300	46696	2907

NOTE--TOTAL 24-HOUR BOARDINGS AT PORTER INCLUDE 558 PERSONS TRANSFERRING FROM COMMUTER RAIL (ALL ALTERNATIVES).

TABLE 7

PARK-RIDE ARRIVALS--ALEWIFE TERMINUS SCHEME

-UNCONSTRAINED--
---PEAK HOUR----

ASSUMED PERCENTAGE DISTRIBUTION OF UNCONSTRAINED ARRIVALS

4.7	5.9	9.0	16.8	10.1	5.3	3.0	45.2

ALEWIFE STATION--

ESTIMATED TIME OF DAY

0645	0715	0745	0815	0845	0915	0945	

UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE

289	362	553	1032	620	325	184	2776
289	651	1204	2236	2856	3181	3365	6141

CONSTRAINED PEAK HOUR

0725		0825	TIMES OF DAY
797		2400	CUMULATIVE ARRIVALS
	1603		PEAK HOUR ARRIVALS

NOTE--ALL ARRIVALS IN PERSONS. ESTIMATED AVERAGE 1.2 PERSONS PER AUTOMOBILE DURING PEAK PERIOD.

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*                                                                          *
* TABLE 8                                                                  *
* PARK-RIDE ARRIVALS--ARLINGTON HEIGHTS TERMINUS SCHEME                    *
*                                                                          *
*                                                                          *
*                            -UNCONSTRAINED--                              *
*                            ---PEAK HOUR----                              *
* ASSUMED PERCENTAGE DISTRIBUTION OF UNCONSTRAINED ARRIVALS                *
*  4.7      5.9      9.0      16.8     10.1      5.3      3.0     45.2     *
*                                                                          *
*                                                                          *
* ARLINGTON HEIGHTS STATION------------------------------------------------ *
*                                                                          *
* ESTIMATED TIME OF DAY                                                    *
*      0640     0710     0740     0810     0840     0910     0940          *
*                                                                          *
* UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE                       *
*    95      119      181      338      204      107      60      911      *
*        95      214      395      733      937     1044     1104     2015  *
*                                                                          *
* CONSTRAINED PEAK HOUR                                                    *
*       0642                0742   TIMES OF DAY                            *
*        103                 420   CUMULATIVE ARRIVALS                     *
*                 317              PEAK HOUR ARRIVALS                      *
*                                                                          *
*                                                                          *
* ARLINGTON CENTER STATION------------------------------------------------- M
*                                                                          *
* ESTIMATED TIME OF DAY                                                    *
*      0640     0710     0740     0810     0840     0910     0940          *
*                                                                          *
* UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE                       *
*   124      156      238      444      267      140      79      1195     *
*       124      280      518      962     1229     1369     1448     2643  *
*                                                                          *
* CONSTRAINED PEAK HOUR                                                    *
*      0628                0728   TIMES OF DAY                             *
*        75                 420   CUMULATIVE ARRIVALS                      *
*                345              PEAK HOUR ARRIVALS                       *
*                                                                          *
*                                                                          *
* NOTE--ALL ARRIVALS IN PERSONS. ESTIMATED AVERAGE 1.2 PERSONS PER         *
*      AUTOMOBILE DURING PEAK PERIOD.                                      *
*                                                                          *
*                                                                          *
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*                                                                              *
* TABLE 8 (CONTINUED)                                                          *
* PARK-RIDE ARRIVALS--ARLINGTON HEIGHTS TERMINUS SCHEME (CONT'D)               *
*                                                                              *
*                                                                              *
* ALEWIFE STATION--------------------------------------------------------      *
*                                                                              *
* ESTIMATED TIME OF DAY                                                        *
*      0645     0715     0745     0815     0845     0915     0945              *
*                                                                              *
* UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE                           *
*   170      214      326      608      366      192      109     1636         *
*       170      384      710     1318     1684     1876     1985     3621     *
*                                                                              *
* DIVERSIONS FROM ARLINGTON HEIGHTS (ESTIMATED AT 35 PERCENT)                  *
*                              110       71       37       21      319         *
*                                                                              *
* DIVERSIONS FROM ARLINGTON CENTER (ESTIMATED AT 50 PERCENT)                   *
*                     49      222      133       70       40      598          *
*                                                                              *
* UNCONSTRAINED ARRIVALS WITH DIVERSIONS--INCREMENTAL AND CUMULATIVE           *
*   170      214      375      940      570      299      170     2553         *
*       170      384      759     1699     2269     2568     2738     5291     *
*                                                                              *
* CONSTRAINED PEAK HOUR (GARAGE FILLS AT 0858)                                 *
*                         0745              0845   TIMES OF DAY                *
*                          759              2269   CUMULATIVE ARRIVALS         *
*                                  1510            PEAK HOUR ARRIVALS          *
*                                                                              *
*                                                                              *
* NOTE--ALL ARRIVALS IN PERSONS. ESTIMATED AVERAGE 1.2 PERSONS PER             *
*       AUTOMOBILE DURING PEAK PERIOD.                                         *
*                                                                              *
*                                                                              *
```

TABLE 9

PARK-RIDE ARRIVALS--ROUTE 128 TERMINUS SCHEME

-UNCONSTRAINED--

---PEAK HOUR----

ASSUMED PERCENTAGE DISTRIBUTION OF UNCONSTRAINED ARRIVALS

4.7	5.9	9.0	16.8	10.1	5.3	3.0	45.2

ROUTE 128 STATION--

ESTIMATED TIME OF DAY

0630	0700	0730	0800	0830	0900	0930	

UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE

158	198	303	565	340	178	101	1521
158	356	659	1224	1564	1742	1843	3364

CONSTRAINED PEAK HOUR (GARAGE FILLS AFTER PEAK PERIOD)

0730		0830	TIMES OF DAY
659		1564	CUMULATIVE ARRIVALS
	905		PEAK HOUR ARRIVALS

LEXINGTON CENTER STATION---

ESTIMATED TIME OF DAY

0635	0705	0735	0805	0835	0905	0935	

UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE

30	37	57	106	63	33	19	283
30	67	124	230	293	326	345	628

DIVERSIONS FROM ARLINGTON HEIGHTS (ESTIMATED AT 10 PERCENT)

				12	6	4	53

UNCONSTRAINED ARRIVALS WITH DIVERSIONS---INCREMENTAL AND CUMULATIVE

30	37	57	106	75	39	23	336
30	67	124	230	305	344	367	703

CONSTRAINED PEAK HOUR (GARAGE FILLS AT 0926)

0735		0835	TIMES OF DAY
124		305	CUMULATIVE ARRIVALS
	181		PEAK HOUR ARRIVALS

NOTE--ALL ARRIVALS IN PERSONS. ESTIMATED AVERAGE 1.2 PERSONS PER AUTOMOBILE DURING PEAK PERIOD.

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TABLE 9 (CONTINUED)
PARK-RIDE ARRIVALS--ROUTE 128 TERMINUS SCHEME (CONT'D)

ARLINGTON HEIGHTS STATION-----------------------------------------------

ESTIMATED TIME OF DAY
        0640    0710    0740    0810    0840    0910    0940

UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE
    55      68      104     195     117     61      35      525
        55      123     227     422     539     600     635     1160

CONSTRAINED PEAK HOUR
                0710                0810    TIMES OF DAY
                123                 420     CUMULATIVE ARRIVALS
                        297                 PEAK HOUR ARRIVALS

ARLINGTON CENTER STATION------------------------------------------------

ESTIMATED TIME OF DAY
        0640    0710    0740    0810    0840    0910    0940

UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE
    122     153     234     436     262     138     78      1172
        122     275     509     945     1207    1345    1423    2595

CONSTRAINED PEAK HOUR
    0629                0729    TIMES OF DAY
    77                  420     CUMULATIVE ARRIVALS
            343                 PEAK HOUR ARRIVALS

NOTE--ALL ARRIVALS IN PERSONS. ESTIMATED AVERAGE 1.2 PERSONS PER
      AUTOMOBILE DURING PEAK PERIOD.
```

TABLE 9 (CONTINUED)

PARK-RIDE ARRIVALS--ROUTE 128 TERMINUS SCHEME (CONT'D)

ALEWIFE STATION

ESTIMATED TIME OF DAY

	0645	0715	0745	0815	0845	0915	0945	
UNCONSTRAINED ARRIVALS--INCREMENTAL AND CUMULATIVE								
Incremental	139	175	266	497	299	157	89	1337
Cumulative	139	314	580	1077	1376	1533	1622	2959
DIVERSIONS FROM ARLINGTON HEIGHTS (ESTIMATED AT 30 PERCENT)				1	35	18	10	158
DIVERSIONS FROM ARLINGTON CENTER (ESTIMATED AT 50 PERCENT)			45	218	131	69	39	586
UNCONSTRAINED ARRIVALS WITH DIVERSIONS--INCREMENTAL AND CUMULATIVE								
Incremental	139	175	311	716	465	244	138	2081
Cumulative	139	314	625	1341	1806	2050	2188	4269

CONSTRAINED PEAK HOUR (GARAGE FILLS AFTER PEAK PERIOD)

0745		0845	TIMES OF DAY
625		1806	CUMULATIVE ARRIVALS
	1181		PEAK HOUR ARRIVALS

NOTE--ALL ARRIVALS IN PERSONS. ESTIMATED AVERAGE 1.2 PERSONS PER AUTOMOBILE DURING PEAK PERIOD.

TABLE 10

SUMMARY OF ESTIMATED 1980 CONSTRAINED PEAK HOUR INBOUND BOARDINGS

STATION	ESTIMATED PEAK HOUR INBOUND BOARDINGS (PERSONS) WALK	BUS	KISS	PARK	TOTAL
ALEWIFE TERMINUS SCHEME					
ALEWIFE	527	1145	648	1603	3923
DAVIS	707	792	675	0	2174
PORTER	447	749	320	0	1666
HARVARD	1000	1954	30	0	2984
TOTAL	2681	4640	1673	1603	10747
ARLINGTON HEIGHTS TERMINUS SCHEME					
ARLINGTON HTS	174	316	380	317	1187
ARLINGTON CTR	494	395	482	345	1716
ALEWIFE	527	552	434	1510	3023
SUBTOTAL	1195	1263	1296	2172	5926
DAVIS	707	792	675	0	2174
PORTER	447	749	320	0	1666
HARVARD	1000	1954	30	0	2984
TOTAL	3349	4758	2321	2172	12750
ROUTE 128 TERMINUS SCHEME					
ROUTE 128	93	41	53	905	1092
LEXINGTON CTR	88	197	46	181	512
ARLINGTON HTS	174	162	288	297	921
ARLINGTON CTR	494	393	481	343	1711
ALEWIFE	527	551	434	1181	2693
SUBTOTAL	1376	1344	1302	2907	6929
DAVIS	707	792	675	0	2174
PORTER	447	749	320	0	1666
HARVARD	1000	1954	30	0	2984
TOTAL	3530	4839	2327	2907	13753

NOTE--TOTAL PEAK HOUR BOARDINGS AT PORTER INCLUDE 150 PERSONS TRANSFERING FROM COMMUTER RAIL (ALL ALTERNATIVES)

12,750

TABLE 11

ESTIMATED DIRECTIONS OF ACCESS FOR PEAK HOUR TRIPS TO ALEWIFE STATION WITH ALEWIFE TERMINUS

ORI- GIN	PERCENT FROM SO.	NO.	W.	BUS TRIPS SO.	NO.	WEST	KISS-RIDE TRIPS SO.	NO.	WEST	PARK-RIDE TRIPS SO.	NO.	WEST
2	70	30	0	106	46	0	0	0	0	0	0	0
3	0	100	0	0	0	0	0	0	0	0	4	0
4	0	100	0	0	79	0	0	124	0	0	44	0
5	0	100	0	0	12	0	0	0	0	0	47	0
6	0	100	0	0	109	0	0	72	0	0	124	0
8	50	0	50	81	0	81	76	0	75	71	0	70
9	0	0	100	0	0	175	0	0	135	0	0	40
10	0	50	50	0	0	0	0	0	0	0	58	58
11	0	0	100	0	0	148	0	0	60	0	0	34
12	0	100	0	0	16	0	0	8	0	0	30	0
13	0	0	100	0	0	83	0	0	62	0	0	217
14	0	0	100	0	0	67	0	0	0	0	0	68
15	0	0	100	0	0	0	0	0	0	0	0	7
16	0	0	100	0	0	32	0	0	0	0	0	90
17	0	100	0	0	64	0	0	0	0	0	152	0
19	0	0	100	0	0	0	0	0	0	0	0	19
20	0	0	100	0	0	0	0	0	0	0	0	29
21	0	100	0	0	0	0	0	0	0	0	13	0
22	0	0	100	0	0	0	0	0	0	0	0	15
23	0	0	100	0	0	0	0	0	0	0	0	21
25	0	100	0	0	0	0	0	0	0	0	36	0
26	0	100	0	0	0	0	0	0	0	0	36	0
27	0	0	100	0	0	0	0	0	0	0	0	4
29	0	0	100	0	0	0	0	0	0	0	0	48
30	0	0	100	0	0	0	0	0	0	0	0	42
31	0	0	100	0	0	0	0	0	0	0	0	90
32	0	0	100	0	0	0	0	0	0	0	0	80
33	0	0	100	0	0	0	0	0	0	0	0	105
SUBTOTALS				187	326	586	76	204	332	71	544	1037
PERCENTS				17.0	29.7	53.3	12.4	33.3	54.3	4.3	32.9	62.8
CONSTRAINED				187	326	586	76	204	332	69	528	1006
DIVERSIONS FROM PARK-RIDE				12	20	36	6	15	25	0	0	0
TOTALS (PERSONS)				199	346	622	82	219	357	69	528	1006
TOTALS (VEHICLES)				7	12	21	68	182	297	57	440	838

NOTES--ASSUMED AVERAGE AUTO OCCUPANCY = 1.2, BUS OCCUPANCY = 30.
ACCESS FROM SOUTH AND NORTH VIA ALEWIFE BROOK PARKWAY,
FROM WEST, VIA ROUTE 2.

TABLE 12
ESTIMATED DIRECTIONS OF ACCESS FOR PEAK HOUR TRIPS TO ALEWIFE STATION WITH ARLINGTON HEIGHTS TERMINUS

ORI-GIN	PERCENT FROM SO.	NO.	W.	ARLINGTON HTS PARK ORIGINS SO.	NO.	WEST	ARLINGTON CTR PARK ORIGINS SO.	NO.	WEST	ARLINGTON CTR BUS ORIGINS SO.	NO.	WEST
5	0	100	0	0	0	0	0	14	0	0	4	0
6	0	100	0	0	0	0	0	176	0	0	55	0
8	50	0	50	0	0	0	22	0	21	13	0	12
9	0	0	100	0	0	0	0	0	62	0	0	0
10	0	50	50	0	21	21	0	98	98	0	0	0
11	0	0	100	0	0	0	0	0	0	0	0	110
13	0	0	100	0	0	19	0	0	40	0	0	50
14	0	0	100	0	0	59	0	0	72	0	0	0
15	0	0	100	0	0	16	0	0	0	0	0	0
16	0	0	100	0	0	28	0	0	0	0	0	0
17	0	100	0	0	16	0	0	51	0	0	38	0
19	0	0	100	0	0	33	0	0	0	0	0	0
20	0	0	100	0	0	37	0	0	0	0	0	0
21	0	100	0	0	41	0	0	0	0	0	0	0
22	0	0	100	0	0	17	0	0	0	0	0	0
23	0	0	100	0	0	24	0	0	0	0	0	0
25	0	100	0	0	38	0	0	4	0	0	1	0
26	0	100	0	0	38	0	0	6	0	0	5	0
30	0	0	100	0	0	48	0	0	0	0	0	0
31	0	0	100	0	0	0	0	0	45	0	0	0
32	0	0	100	0	0	43	0	0	0	0	0	0
33	0	0	100	0	0	43	0	0	2	0	0	0
TOTALS				0	154	388	22	349	340	13	103	172
PERCENTS				0.0	28.4	71.6	3.1	49.1	47.8	4.5	35.8	59.7
DIVERSIONS TO ALEWIFE				0	51	130	11	174	170	2	13	21

TABLE 12 (CONTINUED)

PEAK HOUR ALEWIFE ACCESS/ARLINGTON HEIGHTS TERMINUS (CONT'D)

ORI-GIN	PERCENT FROM SO.	NO.	W.	ALEWIFE BUS TRIPS SO.	NO.	WEST	ALEWIFE KISS-RIDE TRIPS SO.	NO.	WEST	ALEWIFE PARK-RIDE TRIPS SO.	NO.	WEST
2	70	30	0	106	46	0	0	0	0	0	0	0
3	0	100	0	0	0	0	0	0	0	0	4	0
4	0	100	0	0	79	0	0	124	0	0	44	0
5	0	100	0	0	0	0	0	0	0	0	41	0
6	0	100	0	0	0	0	0	0	0	0	69	0
8	50	0	50	81	0	81	61	0	61	47	0	47
9	0	0	100	0	0	91	0	0	74	0	0	27
11	0	0	100	0	0	0	0	0	60	0	0	34
13	0	0	100	0	0	0	0	0	54	0	0	193
14	0	0	100	0	0	0	0	0	0	0	0	39
16	0	0	100	0	0	32	0	0	0	0	0	68
17	0	100	0	0	0	0	0	0	0	0	102	0
20	0	0	100	0	0	0	0	0	0	0	0	6
27	0	0	100	0	0	0	0	0	0	0	0	4
29	0	0	100	0	0	0	0	0	0	0	0	43
31	0	0	100	0	0	0	0	0	0	0	0	50
32	0	0	100	0	0	0	0	0	0	0	0	70
33	0	0	100	0	0	0	0	0	0	0	0	81
SUBTOTALS				187	125	204	61	124	249	47	260	667
DIVERSIONS FROM ARLINGTON				2	13	21	0	0	0	11	225	300
TOTALS (PERSONS)				189	138	225	61	124	249	58	485	967
TOTALS (VEHICLES)				7	5	8	51	103	208	48	404	806

NOTES--ASSUMED AVERAGE AUTO OCCUPANCY = 1.2, BUS OCCUPANCY = 30.
ACCESS FROM SOUTH AND NORTH VIA ALEWIFE BROOK PARKWAY, FROM WEST, VIA ROUTE 2.

TABLE 13

ESTIMATED DIRECTIONS OF ACCESS FOR PEAK HOUR TRIPS TO ALEWIFE STATION WITH ROUTE 128 TERMINUS

ORI- GIN	PERCENT FROM SO.	NO.	W.	ARLINGTON HTS PARK ORIGINS SO.	NO.	WEST	ARLINGTON CTR PARK ORIGINS SO.	NO.	WEST	ARLINGTON CTR BUS ORIGINS SO.	NO.	WEST
5	0	100	0	0	0	0	0	14	0	0	4	0
6	0	100	0	0	0	0	0	176	0	0	55	0
8	50	0	50	0	0	0	22	0	21	13	0	12
9	0	0	100	0	0	0	0	0	62	0	0	0
10	0	50	50	0	21	21	0	98	98	0	0	0
11	0	0	100	0	0	0	0	0	0	0	0	110
13	0	0	100	0	0	19	0	0	40	0	0	50
14	0	0	100	0	0	59	0	0	72	0	0	[illegible]
15	0	0	100	0	0	16	0	0	0	0	0	0
16	0	0	100	0	0	15	0	0	0	0	0	0
17	0	100	0	0	16	0	0	51	0	0	38	0
19	0	0	100	0	0	63	0	0	0	0	0	0
20	0	0	100	0	0	16	0	0	0	0	0	0
21	0	100	0	0	37	0	0	0	0	0	0	0
23	0	0	100	0	0	6	0	0	0	0	0	0
25	0	100	0	0	15	0	0	4	0	0	1	0
26	0	100	0	0	0	0	0	3	0	0	5	0
31	0	0	100	0	0	0	0	0	35	0	0	0
32	0	0	100	0	0	8	0	0	0	0	0	0
33	0	0	100	0	0	0	0	0	2	0	0	0
TOTALS				0	89	223	22	346	330	13	103	172
PERCENTS				0.0	28.5	71.5	3.1	49.6	47.3	4.5	35.8	59.7
DIVERSIONS TO ALEWIFE				0	10	26	11	173	165	2	12	21

TABLE 13 (CONTINUED)

PEAK HOUR ALEWIFE ACCESS/ROUTE 128 TERMINUS (CONT'D)

ORI-GIN	PERCENT FROM SO.	NO.	W.	BUS TRIPS SO.	NO.	WEST	KISS-RIDE TRIPS SO.	NO.	WEST	PARK-RIDE TRIPS SO.	NO.	WEST
2	70	30	0	106	46	0	0	0	0	0	0	0
3	0	100	0	0	0	0	0	0	0	0	4	0
4	0	100	0	0	79	0	0	124	0	0	44	0
5	0	100	0	0	0	0	0	0	0	0	41	0
6	0	100	0	0	0	0	0	0	0	0	69	0
8	50	0	50	81	0	81	61	0	61	47	0	47
9	0	0	100	0	0	91	0	0	74	0	0	27
11	0	0	100	0	0	0	0	0	60	0	0	34
13	0	0	100	0	0	0	0	0	54	0	0	193
14	0	0	100	0	0	0	0	0	0	0	0	39
16	0	0	100	0	0	32	0	0	0	0	0	68
17	0	100	0	0	0	0	0	0	0	0	102	0
29	0	0	100	0	0	0	0	0	0	0	0	15
32	0	0	100	0	0	0	0	0	0	0	0	42
33	0	0	100	0	0	0	0	0	0	0	0	24
SUBTOTALS				187	125	204	61	124	249	47	260	489
DIVERSIONS FROM ARLINGTON				2	12	21	0	0	0	11	183	191
TOTALS (PERSONS)				189	137	225	61	124	249	58	443	680
TOTALS (VEHICLES)				7	5	8	51	103	208	48	369	567

NOTES--ASSUMED AVERAGE AUTO OCCUPANCY = 1.2, BUS OCCUPANCY = 30.
ACCESS FROM SOUTH AND NORTH VIA ALEWIFE BROOK PARKWAY,
FROM WEST, VIA ROUTE 2.

APPENDIX J

MDPW UPDATED ENVIRONMENTAL OVERVIEW
ANALYSIS FOR ALEWIFE ROADWAY IMPROVEMENTS

ENVIRONMENTAL
OVERVIEW
SUMMARY
UPDATE

PROPOSED ROADWAY IMPROVEMENTS
IN THE ALEWIFE CORRIDOR
OF CAMBRIDGE, ARLINGTON AND BELMONT,
MASSACHUSETTS

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS

FAY, SPOFFORD & THORNDIKE, INC.
BOSTON, MASSACHUSETTS

MAY 1977

ENVIRONMENTAL

OVERVIEW

SUMMARY

UPDATE

FOR

PROPOSED ROADWAY IMPROVEMENTS

IN THE ALEWIFE CORRIDOR

OF CAMBRIDGE, ARLINGTON, AND BELMONT,

MASSACHUSETTS

PREPARED FOR

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS

BY

FAY, SPOFFORD & THORNDIKE, INC.
BOSTON, MASSACHUSETTS

MAY, 1977

FOREWORD

This document is an addendum to the Environmental Overview Summary, Transportation Improvements in the Alewife Corridor of Cambridge, Arlington and Belmont, Massachusetts, dated August 1975. It summarizes the study process--environmental, engineering, and public-participation--which led to the selection of a preferred course of action by the Massachusetts Department of Public Works. It also summarizes the potential environmental impacts of the preferred course of action, entitled the Minimum-Build Alternative.

Briefly, the Minimum-Build Alternative involves improvements to Route 2, east of Lake Street, and the Alewife Brook Parkway, between Dewey-Almy Circle and Rindge Avenue, which are intended to improve vehicular and pedestrian safety and access to adjacent development. New direct connections are also provided between Route 2 and the Rindge Avenue Extension, to facilitate access to Cambridge's "Industrial Triangle" area and the proposed MBTA Red Line Extension station/garage at Alewife. The Minimum-Build Alternative places emphasis on improved access and roadway safety; it is not intended to effect substantial increases in traffic capacity within the Alewife corridor.

The Minimum-Build Alternative represents an improvement scheme which the state feels possesses characteristics acceptable to a broadbase segment of the public for a roadway project in the Alewife Corridor. It is also consistent with clear state transportation policy (i.e., emphasis on commutation by public transportation rather than the private automobile) that there be no increase in through-traffic roadway capacity within Route 128 and the Northwest Corridor.

This document's purpose is twofold. First, it is intended to complete the Phase One, Environmental Overview Summary portion of this three-phased project. Second, it is intended to be used as a working document for commencement of the Phase Two, Environmental Assessment and Basic Design portion of the project, one which will both guide the continued technical refinement and assessment of the Minimum-Build Alternative and public interaction with the ongoing study process.

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I PROJECT OVERVIEW

I.1 REVIEW OF PROJECT STATUS

On May 12, 1975, the Massachusetts Department of Public Works commenced performance of a three-phase environmental and engineering study of transportation improvements in the Alewife Corridor of Cambridge, Arlington and Belmont, Massachusetts (see Figure 1). The three study phases consisted of the following:

(1) Preparation of an Environmental Overview Summary of Alternative Improvements.

(2) Preparation of an Environmental Assessment and Draft Engineering Study Report for the Proposed Improvements.

(3) Preparation of the Draft and Final Environmental Documents and Final Engineering Study Report for the Proposed Improvements.

In July and August, 1975, draft and final Environmental Overview Summaries (EOS's) were prepared and reviewed by the Federal Highway Administration's Region One office and the Massachusetts Department of Public Works. The draft EOS was also reviewed by other state and local agencies and the community, including a citizens' task force (Alewife Task Force) organized specifically to provide inputs to this study and a parallel Massachusetts Bay Transportation Authority Red Line rapid transit improvements study.

The EOS contained a summary environmental analysis of the potential environmental impacts of thirteen feasible alternative roadway improvement schemes for the Alewife Corridor. The final EOS also contained a recommendation that four improvement alternatives plus the No-Build Alternative be carried forward for further study. Since that time a continuous process of environmental and engineering refinement of the four remaining alternatives has occurred, including active community participation. The major public review body during this time has been the Alewife Task Force, which is composed of representatives of state agencies, such as the Metropolitan Area Planning Council, Metropolitan District Commission, and Massachusetts Bay Transportation Authority; municipal officials from Cambridge, Arlington, and Belmont; representatives of community and special-interest groups; and private citizens. From this study process a single roadway improvement alternative has evolved, henceforth called the Minimum-Build Alternative.

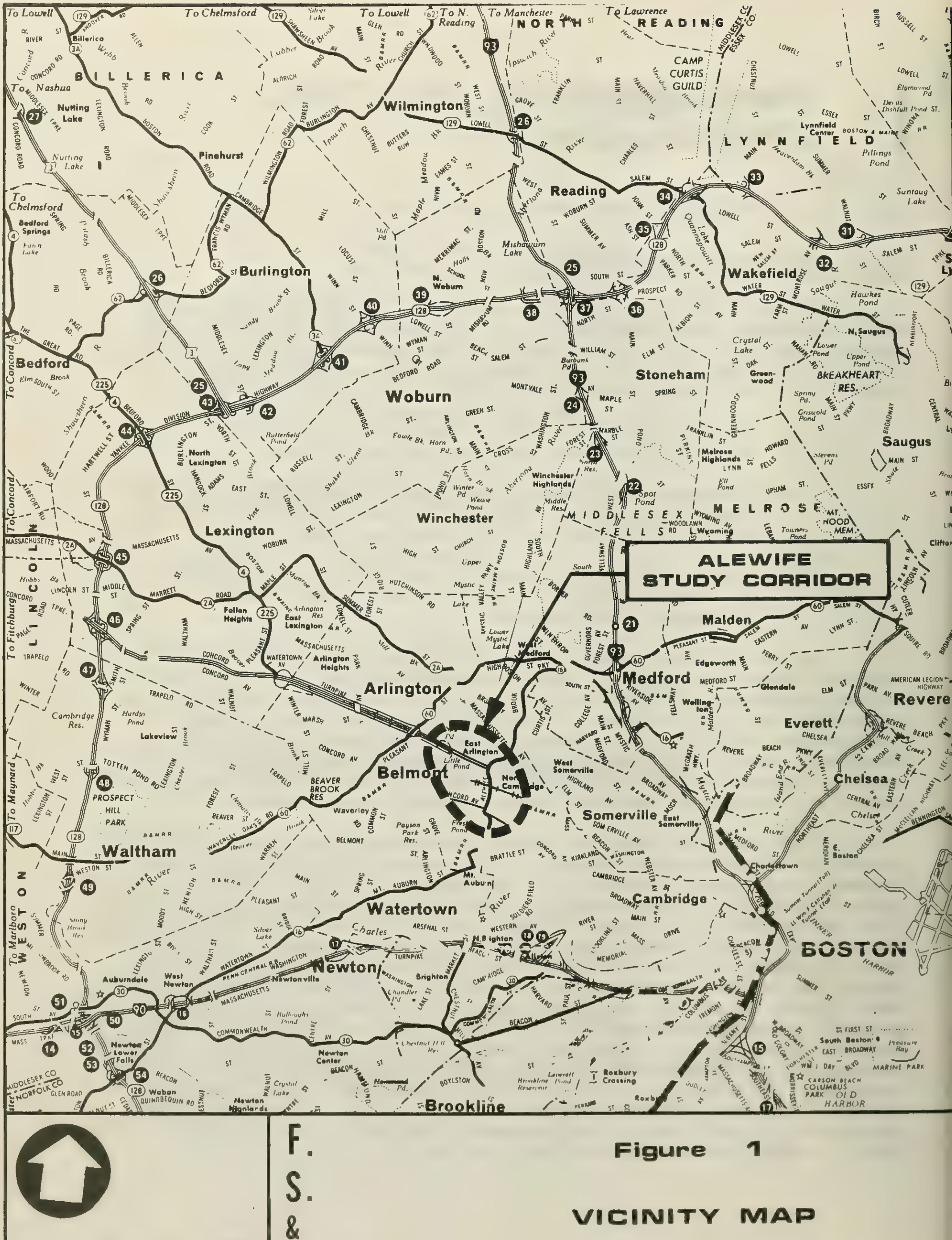

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Figure 1

VICINITY MAP

The Minimum-Build Alternative is the subject of this environmental document, and for the MDPW it represents the preferred roadway improvement, in that it meets basic project objectives relative to improvements in access and safety at a scale which the various public agencies, the municipalities, the community, and special interests such as environmental groups, can accept. This document is intended to serve the twofold function of completing the Phase One, Environmental Overview Summary effort, and commencing the Phase Two, Environmental Assessment and Engineering Basic Design effort.

I.2 SUMMARY OF IMPROVEMENT DEVELOPMENT/EVALUATION PROCESS

EOS Alternatives Evaluation

As mentioned previously, thirteen roadway improvement alternatives were evaluated relative to their engineering features, potential environmental impacts, and reactions from the public in Phase One of this study, between May and August 1975. These improvement alternatives included several developed previously by the Boston Transportation Planning Review (BTPR) and the MDPW, and the remainder developed within this study in response to suggestions and inputs from public officials and the community. All thirteen alternatives addressed three basic project objectives:

(1) Improvement of vehicular and pedestrian safety on the Alewife Brook Parkway and the Concord Turnpike (Route 2).

(2) Improvement of required vehicular and pedestrian access to adjacent development.

(3) Provision of improved vehicular and pedestrian access to the proposed Massachusetts Bay Transportation Authority Red Line station/garage at Alewife.

The third objective described above is, of course, dependent upon action by the United States Urban Mass Transportation Administration as well as the MBTA, and involves the proposed extension of the MBTA's Red Line to Alewife and Arlington. It is important to note here that regardless of whether these agencies eventually construct a station at Alewife in accordance with the proposed transit project, the MDPW views the achievement of the first two objectives listed above as important reasons to proceed with the roadway improvements in this area which are under review here.

With reference to Figure 2, the Alewife study corridor is generally bound by the Route 2/Lake Street interchange on the northwest, the Alewife Brook Parkway/Massachusetts Avenue intersection on the northeast, and the Fresh Pond Parkway/Alewife Brook Parkway/Concord Avenue rotaries on the south.

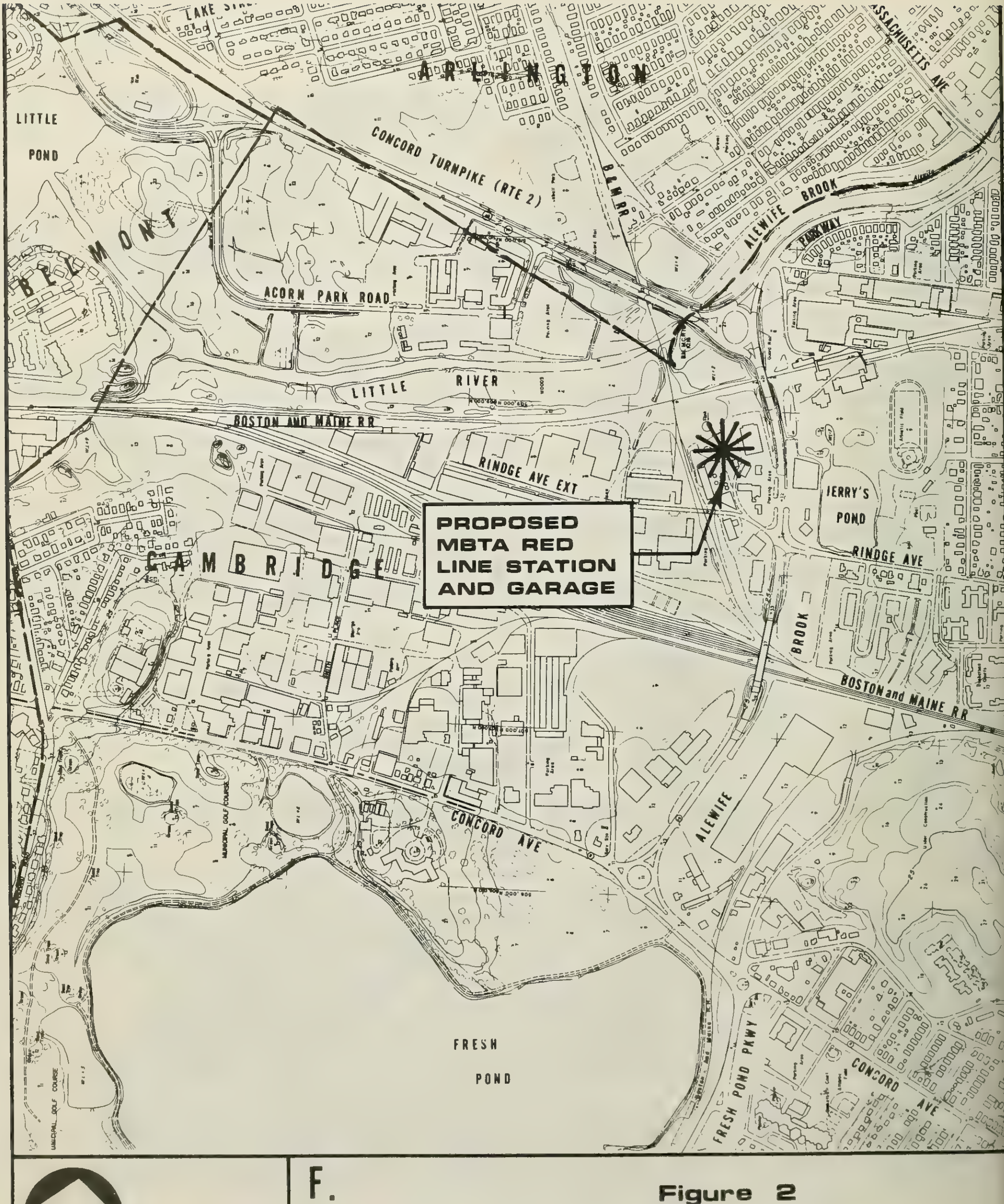

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Figure 2

ALEWIFE TRANSPORTATION NETWORK

The document entitled Environmental Overview Summary, Transportation Improvements in the Alewife Corridor of Cambridge, Arlington and Belmont, Massachusetts, dated August 1975, is herein incorporated by reference. Contained in that document are the evaluations--engineering, environmental, and public-reaction--for the No-Build and the thirteen improvement alternatives originally considered. These alternatives are identified as follows:

(1) Minimum-Build (replace bridges).

(2) Limited-Build (replace bridges/MBTA access).

(3) BTPR Alternative 1 (minimum new construction).

(4) BTPR Alternative 2A (preferential access).

(5) BTPR Alternative 2B (preferential access).

(6) BTPR Alternative 3 (combined bypass/MBTA access).

(7) MDPW Composite BTPR Alternative (major rebuilding).

(8) Study Alternative 1 (frontage roads).

(9) Study Alternative 2 (frontage roads/shopping loop).

(10) Study Alternative 3 (preferential parkway northbound treatment).

(11) Cambridge Alternative C-1 (parkway bypass/MBTA access).

(12) Cambridge Alternative C-1A (parkway bypass/MBTA access).

(13) Linear Park Alternative (open-space constraints on facility).

From these evaluations, the MDPW selected four improvement alternatives from the thirteen above, plus the No-Build Alternative, for further study and refinement. These four EOS improvement alternatives were the following:

(1) Alternative 1: Minimum-Build.

(2) Alternative 2: Limited-Build.

(3) Alternative 7: MDPW Composite BTPR Alternative.

(4) Alternative 13: Linear Park Alternative.

They spanned the total range in roadway scale, from minimum improvement (Alternative 1) to major improvement (Alternative 7).

It should be emphasized that throughout the entire EOS process, the various alternatives were subjected to close public scrutiny through three public participatory mechanisms:

(1) Informational meetings with state agencies, local agencies and municipal officials, and public and private citizens' groups and organizations.

(2) Weekly and biweekly meetings with the citizen advisory group formed especially for this study, the Alewife Task Force.

(3) Public meetings and workshops (2) sponsored by the MDPW for general public comment and input.

Altogether, more than forty meetings were held with public and private organizations and groups to solicit their inputs, concerns, and reactions towards specific roadway improvements.

Post-EOS Alternatives Evaluation

The time period since preparation of the EOS, September 1975 to May 1977, has been spent refining the design concepts contained in the four EOS roadway improvement alternatives brought forward for further study. These refinements were motivated largely by public responses or reactions to specific components of each alternative design. The end product sought, and gained, from this post-EOS evaluation process was a single improvement alternative which met the Department's project objectives, was environmentally and engineeringly sound, and was generally acceptable to a broadbased cross-section of public agencies, the community, and public- and private-interest groups--the proposed Minimum-Build Alternative.

During the first period of the post-EOS alternatives evaluation process (September 1975 to December 1975), emphasis was placed on attempting to achieve public consensus or support for specific roadway improvement design elements, utilizing the four alternatives brought forward from the EOS as a starting point. The primary vehicle for public interaction in this regard continued to be the weekly or biweekly meetings of the Alewife Task Force. In addition, a third public meeting was held and informational meetings with specific public and private groups were continued.

To simplify the alternatives evaluation format, the roadway corridor was divided into four general areas for the purpose of discussion and refinement of alternatives, as follows:

(1) Concord Avenue rotaries/Fresh Pond Shopping Center area of the Alewife Brook Parkway.

(2) Alewife Brook Parkway/Rindge Avenue intersection area, including the two parkway bridges over the railroad tracks (the trestle bridge over the B&M Fitchburg Branch and the span bridge over the B&M Freight Cutoff).

(3) Dewey-Almy Circle area at the intersection of the Alewife Brook Parkway and Route 2.

(4) The Route 2 area, between Dewey-Almy Circle and the Lake Street interchange, and including the potential for direct connection to the proposed MBTA station/garage from Route 2.

Exhibits A through J in the Appendix illustrate several, but not all, of the roadway improvement alternatives developed and evaluated during this refinement period which exemplified alternative methods of roadway treatment (i.e., at-grade versus grade-separated, full-access versus limited-access versus no-access, channelization, signalization, exclusive lanes, etc.) for the four general areas described above. Alternatives that were modifications to the four improvement alternatives brought forward from the EOS (Exhibits A through D), alternatives which were composites of these four alternatives (Exhibits E and F); alternatives which were the result of direct inputs from the public (Exhibit G); and the alternatives which reflected the MDPW's own view of desired roadway improvement (Exhibit H) were developed, evaluated, and discussed with the public during this period.

The general areas of roadway improvement consensus that emerged through public interaction during this time were:

(1) At-grade treatment of the Concord Avenue rotaries on the Parkway and improved connections between the Fresh Pond Shopping Center and the commercial activity opposite the shopping center on the Parkway (Area 1).

(2) Direct connections to the proposed MBTA station/garage from Route 2 (Area 4).

The major areas of public disagreement relative to roadway improvement treatment were:

(1) At-grade versus grade-separation treatment of the Parkway-Rindge Avenue intersection (Area 2).

(2) At-grade versus grade-separation treatment of Dewey-Almy Circle at the intersection of Alewife Brook Parkway and Route 2 (Area 3).

At issue, basically, was the roadway scale whcih the proposed roadway should assume:

(1) Minimum roadway improvement to meet project objectives.

(2) Major roadway improvement to meet project objectives.

A new Minimum-Build Alternative, different in definition from the EOS version, was then developed in response to requests of the Alewife Task Force for a minimum roadway improvement alternative, and is shown as Exhibit J in the Appendix. It consisted basically of meeting project objectives relative to direct connections to the proposed MBTA station/garage from Route 2, improved safety at Dewey-Almy Circle by replacement of the substandard rotary with an at-grade, signalized, channelized "T" intersection, and improved access to adjacent development, specifically to the "Industrial Triangle" area off Rindge Avenue Extension (via continuation of the Route 2 ramp connections to the MBTA station/garage to the Rindge Avenue Extension). This Minimum-Build Alternative, different from the EOS version, represented a minimum investment alternative to the Department, and differed from the Alewife Task Force's definition of a minimum-build in two major areas:

(1) Repair or replacement of the two substandard and physically deteriorated bridges over the B&M railroad was relegated to the MDC, the agency having jurisdiction, and/or a separate project.

(2) Improvements to the Parkway south of Rindge Avenue, and specifically in the Concord Avenue and Fresh Pond Shopping Center area, were also relegated to the MDC and/or a separate project.

With the assistance of the Alewife Task Force, the various post-EOS major roadway improvement alternatives were narrowed to one, the Modified-Star Alternative, shown in Exhibit I (a subsequent revision of the Modified-Star Alternative is shown as Exhibit H). This alternative provided the same direct connections to the proposed MBTA station/garage and the Industrial Triangle area of Cambridge as the then current version of the Minimum-Build, but differed in that it employed grade separations at Dewey-Almy Circle and Rindge Avenue to meet other access and safety objectives; provided for replacement of the two substandard bridges over the railroad on the Parkway; and also provided improved safety and access in the Concord Avenue/Fresh Pond Shopping Center area. Improved traffic service also resulted from the grade separations in the Route 2/Dewey-Almy Circle and Alewife Brook Parkway/Rindge Avenue areas. This Modified-Star Alternative represented a maximum investment alternative to the Department.

The Minimum-Build Alternative and the Modified-Star Alternative roadway concepts together represented the end products of the September 1975 to December 1975 period of the post-EOS alternative evaluation process, this period being one of refinement and reduction of alternatives to two, a minimum roadway improvement option and a major roadway improvement option.

A second refinement and evaluation period, from January 1976 to July 1976, involved reducing the number of roadway improvement options down to a single alternative, the choice being between the Minimum-Build and Modified-Star Alternatives. The major public

interaction mechanism throughout this period continued to be the Alewife Task Force, with informational meetings again also held with specific public officials and community and private-interest groups.

A growing public preference for a minimum-scale roadway improvement alternative, especially from the standpoint of community and environmental groups, developed during this period, because of the potentially disruptive effects seen by these groups of a major build alternative such as the Modified-Star on the local area's human and natural environments. As a result, the Massachusetts Secretary of Transportation and Construction announced to the Alewife Task Force in July 1976 his decision to have the MDPW drop the Modified-Star Alternative from further consideration. Only the general concept of a Minimum-Build Alternative, which in scale was acceptable to a broader scale of the public than the Modified-Star Alternative, was to be considered further.

The third and final period of the post-EOS alternatives evaluation process, August 1976 to May 1977, was one of refinement of the various conceptual design components of the Minimum-Build Alternative, particularly in light of the parallel MBTA Alewife station/garage design project. Exhibit K exemplifies two of several such refinements, as compared to Exhibit J:

(1) Alternative ramp treatment of the direct connection between Route 2 and the proposed MBTA station/garage.

(2) Prohibition of direct access from Route 2 to existing commercial development east of the Lake Street interchange and provison of replacement access to the rear of this development via the Lake Street interchange and Arthur D. Little, Inc.'s Acorn Park Road.

A subsequent refinement was replacement, rather than repair, of the Parkway bridge over the Boston and Maine Railroad's Freight Cutoff.

The end product of this refinement process was the proposed course of action, the final Phase One version of the Minimum-Build Alternative, which is described in the next section.

I.3 DESCRIPTION OF PROPOSED IMPROVEMENT

The proposed improvement, the Minimum-Build Alternative, is shown in Figure 3. The major features of this alternative are the following:

(1) Elimination of direct access to abutting land-use development on both sides of Route 2 (Concord Turnpike), and reconstruction and minor relocation of Route 2, between the Lake Street interchange and Dewey-Almy Circle. Provision of replacement access to southside Route 2 development via a connection from Acorn Park Road.

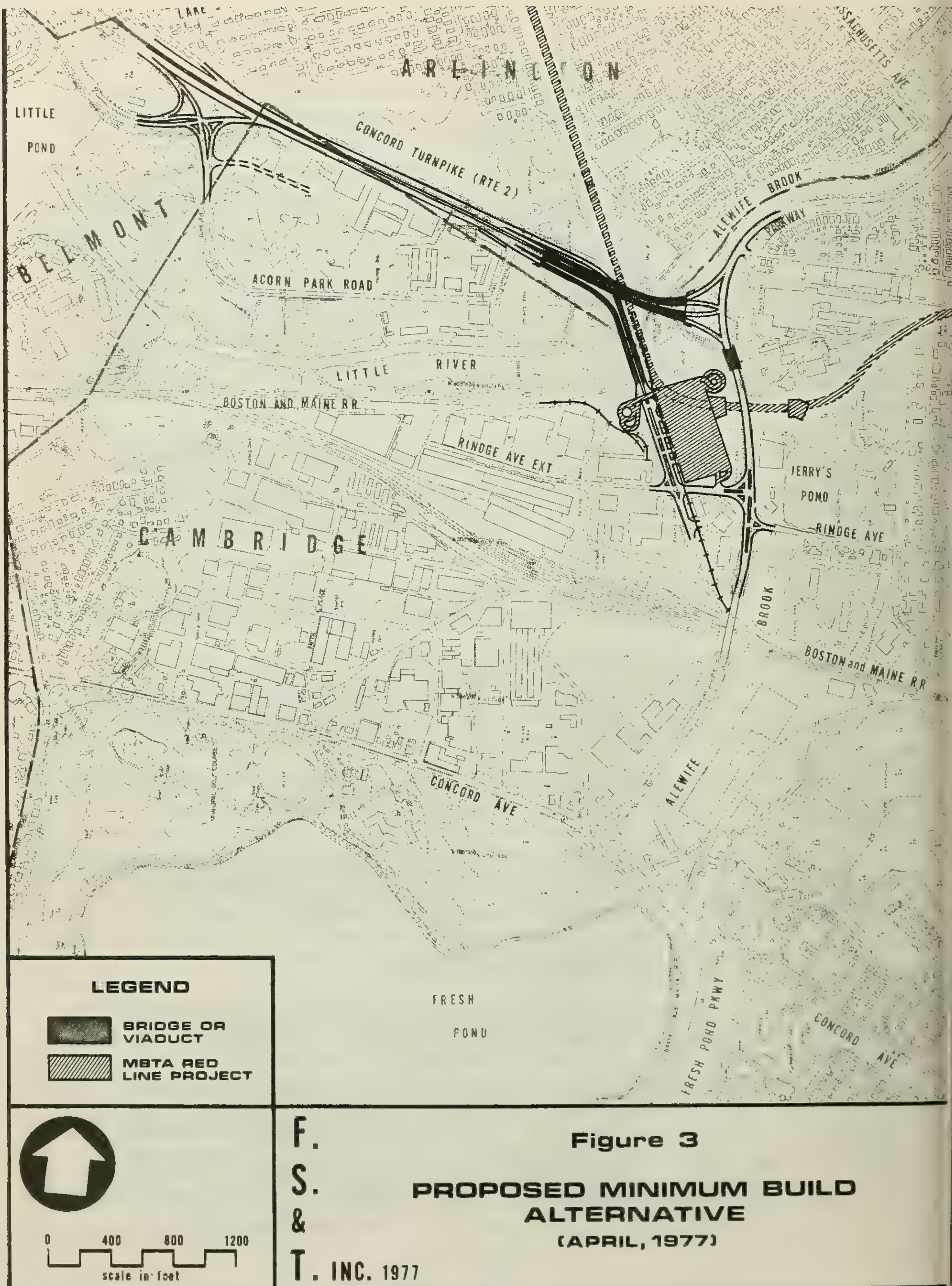

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Figure 3

PROPOSED MINIMUM BUILD ALTERNATIVE
(APRIL, 1977)

(2) Direct roadway connections between Route 2 and the Rindge Avenue Extension, including access to the proposed MBTA Red Line Extension station/garage at Alewife.

(3) Replacement of the Dewey-Almy rotary at Route 2 and the Alewife Brook Parkway with an at-grade, signalized and channelized "T"-intersection.

(4) Replacement of the substandard bridge over the Boston and Maine Freight Cutoff on the Alewife Brook Parkway.

(5) Improvement of the existing at-grade, signalized intersection of the Alewife Brook Parkway and Rindge Avenue through realignment, new signalization, and channelization.

Between the Lake Street interchange and Dewey-Almy Circle on Route 2, direct access presently exists to abutting development on the south side. No direct access to abutting land presently exists on the north side of Route 2, although such access has not been specifically prohibited by the Massachusetts Department of Public Works through a line of no-access. The Minimum-Build Alternative proposes to prohibit direct access to abutting development on both sides of Route 2 along this section for safety reasons, due to the high operating speeds of vehicles on Route 2 entering or leaving the Alewife area to the west. Southside replacement access will be provided via a new access road to the rear of the southside development, connecting to Arthur D. Little, Inc.'s (ADL's) Acorn Park Road via a "T"-intersection approximately 200 feet south of the existing signalized intersection at Acorn Park Road and the Lake Street interchange. To facilitate this new access, and to replace ADL's direct connection to Route 2 eastbound, which is situated approximately 2,000 feet to the east and which will be closed under the Minimum-Build Alternative, a direct connection from Route 2 eastbound to Acorn Park Road will be added at the Lake Street interchange. All other Lake Street interchange connections will be maintained.

Between the Lake Street interchange and the proposed direct connections from Route 2 to the Rindge Avenue Extension and MBTA station/garage, Route 2 will consist of three travel lanes in each direction to effect a proper transition between the four-lane directional cross-section for Route 2 west of Lake Street and the two-lane directional approaches of Route 2 to the Alewife Brook Parkway at the Dewey-Almy Circle intersection. In addition, an auxiliary weaving lane will be required for the outbound travel direction to safely accommodate weaving which will occur between Route 2 westbound traffic desiring to exit at the Lake Street interchange and Rindge Avenue Extension-MBTA station/garage outbound traffic desiring to proceed westward on Route 2.

The new direct connections between Route 2 and the Rindge Avenue Extension are intended to provide improved access to Cambridge's Industrial Triangle area, an area presently characterized by

predominantly industrial uses, but with potential for various higher-intensity industrial, commercial, and other uses. They will also serve to provide direct connections from Route 2 to the MBTA station/garage. These connections generally follow the right-of-way of the Boston and Maine Railroad's Bedford Branch, from Route 2 to the Rindge Avenue Extension. Inbound from Route 2, the new ramp connection will begin to diverge from existing Route 2 in the approximate vicinity of the Chalet Motor Inn on the south side and cross through the MDC's Alewife Brook Reservation and the Little River on viaduct before it meets existing grade in the vicinity of the Boston and Maine Railroad's Freight Cutoff. The inbound connection then continues at approximately existing grade to Rindge Avenue Extension. Outbound from Rindge Avenue Extension to Route 2, the new outbound connection maintains the same profile, at approximately existing grade, between Rindge Avenue Extension and the Freight Cutoff; also crosses the Alewife Brook Reservation and the Little River predominantly on viaduct; and passes beneath Route 2 and merges with Route 2 westbound in the vicinity of the boundary between the Thorndike Street Playground and property owned by the Mugar Group. The profiles of the Route 2 connectors north of the Freight Cutoff have been established to allow for a pedestrian underpass beneath them. To avoid encroachment of the outbound connection into the Thorndike Street Playground, a potential Section 4(f) land, the alignment of Route 2 in this vicinity has been shifted southward toward ADL and the Alewife Brook Reservation, where encroachment can not be avoided. The cross-section of the Route 2-Rindge Avenue Extension connector generally consists of two 12-foot travel lanes in each direction with exclusive left-turn storage lanes and channelization at the MBTA station/garage to facilitate access. The Rindge Avenue Extension-Route 2 Connection intersection will be signalized and coordinated with new signalization at the improved Rindge Avenue-Alewife Brook Parkway intersection and with signalization and signing of the various station/garage access points. Railroad preemption devices will be provided at all at-grade railroad crossings in this area.

Access to the proposed MBTA station/garage from the Route 2 connection inbound for park-and-ride traffic will be accomplished via a double-helix, grade-separated ramping system which will feed this traffic into upper parking levels of the garage. This grade-separated structure is not part of the Minimum-Build Alternative, but, rather, constitutes part of the MBTA's station/garage project. Park-and-ride traffic destined outbound on the Route 2 Connector, and kiss-and-ride and bus traffic destined both inbound and outbound, will gain access to the station/garage at grade. The at-grade access-egress openings along the Route 2 Connector for the proposed MBTA station/garage are included as part of the Minimum-Build Alternative. These openings will be signalized and signed so that station/garage traffic will mix safely and efficiently with general traffic on the Route 2 Connectors.

Route 2 eastbound and westbound, in the vicinity of the Boston and Maine Railroad's Bedford Branch (Rindge Avenue Extension connections) to the Alewife Brook Parkway at Dewey-Almy Circle, will each consist of three 12-foot travel lanes with shoulders, and will

cross the Boston and Maine Railroad's Bedford Branch, the outbound connection from the Rindge Avenue Extension and the Alewife Brook on viaduct. To increase traffic safety at Dewey-Almy Circle, consistently one of the most hazardous (high-accident) locations in Massachusetts, the substandard rotary will be replaced by a signalized, channelized, at-grade "T"-intersection and will be raised in grade approximately five feet to improve vertical sight distances on both the Alewife Brook Parkway and Route 2 at their approaches to this intersection. The Alewife Brook Parkway approaches to this intersection will consist of two 11-foot travel lanes with a shoulder. The Route 2 eastbound approaches at Dewey-Almy will consist of two 12-foot travel lanes with shoulders for Parkway southbound traffic and one 12-foot travel lane with shoulders for Parkway northbound traffic.

North of the signalized "T"-intersection at Dewey-Almy, the four improved traffic lanes will meet the existing Parkway cross-section before Massachusetts Avenue. Access to Whittemore Avenue will basically remain unchanged; however, the intersection will be signalized and coordinated with signalization at the Parkway/ Route 2 intersection. South of the Dewey-Almy intersection, the existing substandard and deteriorated four-lane, 40-foot curb-to-curb bridge over the Boston and Maine Railroad's Freight Cutoff will be replaced by a new bridge with four 11-foot travel lanes, shoulders, and sidewalk. This cross-section will be continued southward to an improved Rindge Avenue intersection.

The approaches to the existing Rindge Avenue/Rindge Avenue Extension intersection will be realigned, widened to accommodate some traffic movements, and channelized, for safety purposes and to prohibit or restrict other traffic movements. Specifically, the Rindge Avenue Extension approach to the Parkway will be realigned northward to create a so-called "dogleg" intersection. To facilitate access to the MBTA station/garage and other Rindge Avenue Extension development from the north on the Parkway, a free right-hand-turn lane will be provided at the southbound approach to the intersection. Access into Rindge Avenue from Alewife Brook Parkway will be prohibited from the north (as presently exists today), and as a result of realignment and channelization, from Rindge Avenue Extension (which is presently permitted). These improvements will decrease this residential street's use as a short cut into Cambridge and Boston by traffic from the northwest. Such treatment of this intersection is an expressed desire of Cambridge city officials and the North Cambridge Neighborhood itself. Access to Rindge Avenue from the Alewife Brook Parkway will only be permitted from the south.

The proposed project terminates on the Alewife Brook Parkway just north of the trestle bridge over the Boston and Maine Railroad's Fitchburg Branch. To accommodate the proposed direct connection between Route 2 and the Rindge Avenue Extension, including access to the proposed MBTA station/garage, a portion of the Boston and Maine's Bedford Branch Line to the south of the Freight Cutoff will be relocated. In addition, rail spur access to Bethlehem Steel,

located on the Rindge Avenue Extension adjacent to the new connection, will be relocated from the Bedford Branch to the Freight Cutoff. Both rail relocations are included as part of the Minimum-Build Alternative.

Viaduct, rather than embankment, is proposed for portions of the Route 2 roadway and the Rindge Avenue Extension connector roadways for several reasons. These include less encroachment on the Alewife Brook Reservation, less encroachment and impact on the Alewife Brook floodplain, the potential for providing replacement flood storage occasioned by removal of the existing Route 2 embankment, and the increased potential for pedestrian/bicycle connectivity and accessibility through the area. In addition, existing soils conditions in the area, with underlying layers of clay and silt, would necessitate any embankment which would support roadways to be surcharged (preloaded) for a period of from one to two years. The required profile for the surcharged embankment would be up to ten feet higher than the final embankment profile, to allow for required compaction. This higher profile would in turn result in side slopes extending further into the Reservation and floodplain, with resultant increased impacts on vegetation, wildlife, and floodplain storage. The ability to restore the area covered by the surcharge to its existing condition once the final embankment configuration is achieved is very questionable. In addition, during the surcharge period, additional areas will be required to provide sediment basins for embankment runoff, to minimize siltation of the area's water bodies. Therefore, embankment treatment of the roadways in this area is not proposed.

II ENVIRONMENTAL ANALYSIS

II.1 TRAFFIC SERVICE AND SAFETY

Traffic Service

Traffic service is measured by the volume of traffic carried by a particular segment of a roadway network relative to the physical and operational capacity of that segment, where capacity is the maximum number of vehicles which can be accommodated by a roadway or an intersection during a given period of time under prevailing conditions. The Highway Capacity Manual (Highway Research Board Special Report 87, 1965) has defined six discrete levels of service (LOS) to describe the actual traffic operating conditions. In general, these levels range from LOS "A," which is associated with relatively free flow conditions and average overall travel speeds in excess of 30 miles per hour (mph), to LOS "F," which is represented by forced flow conditions with jammed operation (speeds are less than 15 mph) and traffic in excess of maximum capacity. The capacity required to produce LOS "C" is customarily used as the "Design Capacity" of a roadway and LOS "C" is often used to represent the "Design Level of Service" for a roadway. LOS "C" is indicative of stable flow conditions with acceptable delays and speeds of 20 mph or more in an urban context.

Annual average daily traffic volumes (AADT's) and AM and PM peak-hour volumes for 1975 were developed, based on field traffic measurements conducted during the spring of 1975, and used to forecast peak-hour and AADT volumes for 1980 and 2000 for the roadway network depicted on Figure 4. Table 1 identifies the roadway links and intersections evaluated in the network. AADT volumes for 1975, 1980, and 2000 are presented in Table 2 for the network. The levels of service for each link and intersection for the existing roadway network in 1975 during the AM and PM peak travel periods are presented in Table 3, which reveals that seven of the 17 existing locations experienced volumes in excess of their design capacities (LOS "C") during the AM period, and five of the 17 locations exceeded design capacity during the PM peak period. The critical capacity constraints with present traffic levels are primarily the intersections and rotaries, not the roadway links. The most critical roadway link constraint was Lake Street, north of Route 2.

Level of service computations were made for the Minimum-Build Alternative for the year 2000 forecasted traffic, and compared to the comparable LOS for the No-Build Alternative. These computations are contained in Table 4. Table 4 indicates that the proposed improvements will not significantly improve the level of service on the roadway network in the design year (2000). Design capacity

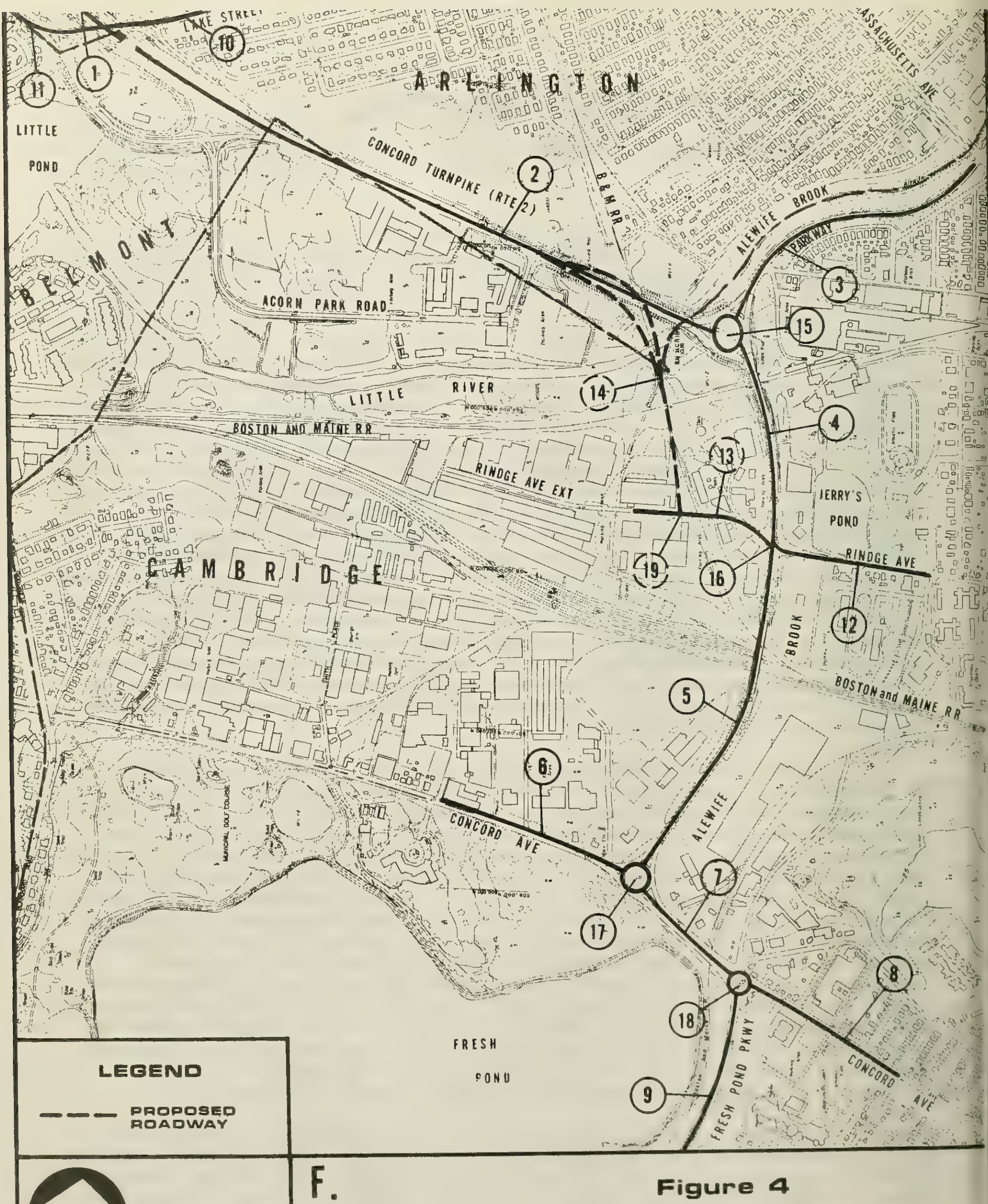

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Figure 4

ROADWAY LINK AND INTERSECTION IDENTIFICATION

Table 1

ROADWAY LINK AND INTERSECTION IDENTIFICATION

Location		Description
Link	1	Route 2, west of Lake Street
	2	Route 2, Lake Street to Dewey-Almy
	3	Alewife Brook Parkway, north of Dewey-Almy
	4	Alewife Brook Parkway, Dewey-Almy to Rindge Avenue
	5	Alewife Brook Parkway, Rindge Avenue to Concord Avenue
	6	Concord Avenue, west of Alewife Brook Parkway
	7	Concord Avenue, Alewife Brook Parkway to Fresh Pond Parkway
	8	Concord Avenue, east of Fresh Pond Parkway
	9	Fresh Pond Parkway, south of Concord Avenue
	10	Lake Street, north of Route 2
	11	Lake Street, south of Route 2
	12	Rindge Avenue, east of Alewife Brook Parkway
	13	Rindge Avenue Extension, west of Alewife Brook Parkway
	14	Proposed Connector from Route 2 to Rindge Avenue Extension
Intersection	15	Dewey-Almy Rotary
	16	Rindge Avenue and Alewife Brook Parkway
	17	Alewife Brook Parkway and Concord Avenue Rotary
	18	Fresh Pond Parkway and Concord Avenue Rotary
	19	Proposed Route 2 Connector and Rindge Avenue Extension

Table 2

TWO-WAY AVERAGE ANNUAL DAILY TRAFFIC
1975, 1980, 2000

Location		AADT Volumes 1975	1980	2000
1.	Route 2, west of Lake Street	41,500	47,000	58,000
2.	Route 2, Lake Street to Dewey-Almy	44,500	58,630	70,380
3.	Alewife Brook Parkway, north of Dewey-Almy	32,200	36,850	40,570
4.	Alewife Brook Parkway, Dewey-Almy to Rindge Avenue	48,900	56,710	62,290
5.	Alewife Brook Parkway, Rindge Avenue to Concord Avenue	45,900	60,000	67,570
6.	Concord Avenue, west of Alewife Brook Parkway	17,600	22,570	24,860
7.	Concord Avenue, Alewife Brook Parkway to Fresh Pond Parkway	49,600	59,000	64,880
8.	Concord Avenue, east of Fresh Pond Parkway	13,300	17,130	18,750
9.	Fresh Pond Parkway, south of Concord Avenue	43,000	55,250	60,750
10.	Lake Street, north of Route 2	11,800	12,000	13,170
11.	Lake Street, south of Route 2	9,500	9,780	10,780
12.	Rindge Avenue, east of Alewife Brook Parkway	11,000	13,000	14,330
13.	Rindge Avenue Extension, west of Alewife Brook Parkway	4,600	5,500	6,000
14.	Proposed Connector from Route 2 to Rindge Avenue Extension	*	**	**
15.	Dewey-Almy Rotary(a)	62,800	76,100	86,600
16.	Rindge Avenue and Alewife Brook Parkway Intersection(a)	55,200	67,600	75,100
17.	Alewife Brook Parkway and Concord Avenue Rotary(a)	56,600	70,800	78,700
18.	Fresh Pond Parkway and Concord Avenue Rotary(a)	53,000	65,700	72,200
19.	Proposed Route 2 Connector and Rindge Avenue Extension Intersection(a)	*	**	**

(a) AADT entering volume totals given for intersections and rotaries.
* Not applicable.
** Peak-hour forecasts only.

Table 3

1975 LEVEL OF SERVICE

Location		Level of Service AM Peak	PM Peak
1.	Route 2, west of Lake Street	A	A
2.	Route 2, Lake Street to Dewey-Almy	B	B
3.	Alewife Brook Parkway, north of Dewey-Almy	B	B
4.	Alewife Brook Parkway, Dewey-Almy to Rindge Avenue	D	B
5.	Alewife Brook Parkway, Rindge Avenue to Concord Avenue	C	B
6.	Concord Avenue, west of Alewife Brook Parkway	A	A
7.	Concord Avenue, Alewife Brook Parkway to Fresh Pond Parkway	C	B
8.	Concord Avenue, east of Fresh Pond Parkway	D	B
9.	Fresh Pond Parkway, south of Concord Avenue	B	B
10.	Lake Street, north of Route 2	E	E
11.	Lake Street, south of Route 2	A	B
12.	Rindge Avenue, east of Alewife Brook Parkway	C	C
13.	Rindge Avenue Extension, west of Alewife Brook Parkway	C	C
14.	Proposed Connector from Route 2 to Rindge Avenue Extension	*	*
15.	Dewey-Almy Rotary	F	F
16.	Rindge Avenue and Alewife Brook Parkway Intersection	D	F
17.	Alewife Brook Parkway and Concord Avenue Rotary	E	E
18.	Fresh Pond Parkway and Concord Avenue Rotary	E	E
19.	Proposed Route 2 Connector and Rindge Avenue Extension Intersection	*	*

* Not applicable.

Table 4

YEAR 2000 LEVELS OF SERVICE
(PEAK HOUR--WORST CASE)

Location		No-Build	Minimum-Build
1.	Route 2, west of Lake Street	A	A
2.	Route 2, Lake Street to Dewey-Almy	F	D
3.	Alewife Brook Parkway, north of Dewey-Almy	B	B
4.	Alewife Brook Parkway, Dewey-Almy to Rindge Avenue	F	F
5.	Alewife Brook Parkway, Rindge Avenue to Concord Avenue	F	F
6.	Concord Avenue, west of Alewife Brook Parkway	A	A
7.	Concord Avenue, Alewife Brook Parkway to Fresh Pond Parkway	E	E
8.	Concord Avenue, east of Fresh Pond Parkway	F	F
9.	Fresh Pond Parkway, south of Concord Avenue	D	D
10.	Lake Street, north of Route 2	F	F
11.	Lake Street, south of Route 2	B	B
12.	Rindge Avenue, east of Alewife Brook Parkway	C	C
13.	Rindge Avenue Extension, west of Alewife Brook Parkway	C	C
14.	Proposed Connector from Route 2 to Rindge Avenue Extension	*	C
15.	Dewey-Almy Rotary	F	F
16.	Rindge Avenue and Alewife Brook Parkway Intersection	F	F
17.	Alewife Brook Parkway and Concord Avenue Rotary	F	F
18.	Fresh Pond Parkway and Concord Avenue Rotary	F	F
19.	Proposed Route 2 Connector and Rindge Avenue Extension Intersection	*	F

* Not applicable.

(LOS "C") would be exceeded at 11 of 17 existing roadway locations for both the No-Build and Minimum-Build Alternatives. Maximum capacity (LOS "F") would be exceeded on several roadway links for both alternatives and at all intersections, including the proposed Route 2 Connection/Rindge Avenue Extension intersection under the Minimum-Build Alternative. Only LOS on Route 2, between Lake Street and Dewey-Almy Circle, would improve under the Minimum-Build Alternative, from "F" to "D." These statistics affirm the fact that the proposed improvements are more safety- and access-related than traffic-service-related.

Vehicular traffic on some local roadways may also increase in the future as a resul t of motorists attempting to bypass the heavily congested portions of Route 2 and the Alewife Brook Parkway under the No-Build and Minimum-Build Alternatives. This impact can not be measured, but could adversely affect the residential character of the neighborhoods experiencing this increased traffic. However, a positive feature of the Minimum-Build Alternative in this regard is the improved Parkway/Rindge Avenue intersection. The "dogleg" design, plus channelization and signing, is intended to prohibit encroachment by Parkway southbound traffic and Rindge Avenue Extension traffic into the North Cambridge neighborhood.

Safety

Safety of traffic operation was measured for the same roadway network. Accident data, for the three-year period from January 1, 1972 to December 31, 1974, was obtained from the Massachusetts Registry of Motor Vehicles. During this period, 635 accidents were reported on the network, or an average of 212 accidents yearly. Nearly 45 per cent of these accidents occurred at the Dewey-Almy rotary (intersection of Alewife Brook Parkway and Route 2) and the Rindge Avenue-Alewife Brook Parkway intersection. Factors contributing to these hazardous intersections are heavy traffic volumes, substandard rotary and intersection designs, and restrictions created by the bridges over the Boston and Maine Railroad's Fitchburg Branch and Freight Cutoff. Table 5 indicates the number of accidents occurring at each location on the roadway network during the three-year period ending in December, 1974.

Accident reduction factors for each type of roadway improvement, based on published research (i.e., Traffic Control and Roadway Elements, Highway Users Federation for Safety and Mobility, 1970), were developed to determine the relative safety of operation of the improved roadway. The specific values of the accident reduction factors to be applied to each roadway segment and intersection were dependent upon the types and combinations of improvements recommended. The estimated annual accident reduction with the Minimum-Build Alternative, based on the recorded yearly average for 1972 to 1974, is presented in Table 6 and compared to the No-Build Alternative. Also listed are the annual and facility-service-life (1980 to 2000) dollar savings attributable to this accident reduction. (The average cost of $4,500 for each accident was determined by using National Safety Council accident cost data. The 20-year savings are

Table 5

1972-1974 ROADWAY ACCIDENT DATA

Location		Accidents
1.	Route 2, west of Lake Street	74
2.	Route 2, Lake Street to Dewey-Almy	24
3.	Alewife Brook Parkway, north of Dewey-Almy	1
4.	Alewife Brook Parkway, Dewey-Almy to Rindge Avenue	4
5.	Alewife Brook Parkway, Rindge Avenue to Concord Avenue	51
6.	Concord Avenue, west of Alewife Brook Parkway	28
7.	Concord Avenue, Alewife Brook Parkway to Fresh Pond Parkway	2
8.	Concord Avenue, east of Fresh Pond Parkway	4
9.	Fresh Pond Parkway, south of Concord Avenue	5
10.	Lake Street, north of Route 2	27
11.	Lake Street, south of Route 2	7
12.	Rindge Avenue, east of Alewife Brook Parkway	16
13.	Rindge Avenue Extension, west of Alewife Brook Parkway	2
14.	Proposed Connector from Route 2 to Rindge Avenue Extension	*
15.	Dewey-Almy Rotary	181
16.	Rindge Avenue and Alewife Brook Parkway Intersection	89
17.	Alewife Brook Parkway and Concord Avenue Rotary	42
18.	Fresh Pond Parkway and Concord Avenue Rotary	78
19.	Proposed Route 2 Connector and Rindge Avenue Extension Intersection	*
		635

* Not applicable.

Table 6

ACCIDENT REDUCTION SAVINGS

Alternative	Estimated Annual[(1)] Accident Reduction	Estimated Annual[(2)] Savings	Estimated 20-Year[(3)] Savings
No-Build	0	$ 0	$ 0
Minimum-Build	18	81,000	1,620,000

(1) Base of comparison is the No-Build Alternative and an annual average of 212 accidents (1972-1974) for that alternative (i.e., estimated annual accident reduction for the No-Build Alternative is 0).

(2) $4,500 per accident based on National Safety Council data.

(3) 1980 to 2000 operational time period.

useful for measuring the benefits provided by the proposed improvements.)

This reduction in accidents is a result of several factors, including the improved signalization of the Alewife Brook Parkway/ Rindge Avenue/Rindge Avenue Extension intersection; increased lane widths (from 10 feet to 11 feet) and shoulders on the Parkway; replacement of the Dewey-Almy rotary with a traffic-responsive signalized intersection; improvement of sight distances by revising existing roadway alignments and profiles; provision of proper channelization of traffic; and elimination of direct access and egress to businesses along Route 2. (No reductions in accident occurrence will result south of the trestle bridge over the Boston and Maine Railroad's Fitchburg Main Line under this proposal because of the limits of the improvements.)

The 18 accidents reduced yearly represent approximately a 17-per cent yearly reduction in accidents for that portion of the total Alewife area network improved by the Minimum-Build Alternative and 8 per cent yearly for the total Alewife area network.

II.2 REGIONAL AND COMMUNITY GROWTH

Regional Growth

The proposed highway-related improvements under the Minimum-Build Alternative are primarily safety-oriented in nature and do more to improve local access to adjacent land uses than to improve regional accessibility, and therefore should not significantly affect long-term regional population, employment, and economic growth patterns. The proposed MBTA Red Line Extension from Harvard Square to Arlington Heights, in contrast, with a station complex at Alewife, should have a greater effect on regional growth patterns than the highway improvements at Alewife because it is a regional transportation system. The construction industry and the economy of the region should, however, experience a short-term beneficial impact from the Minimum-Build Alternative, due to increased construction employment opportunities and the subsequently increased purchasing power of those employed.

Community Growth

The development of vacant lands in the Town of Arlington adjacent to Route 2 in the Alewife area will not be enhanced by the proposed improvements because access to these lands, the Mugar site in particular, is not being provided for safety reasons. The Mugar site, which lies north of Route 2 and adjacent to Thorndike Street Playground, is one of two sizable, vacant, potentially developable sites remaining in Arlington. The site is presently zoned for high-density, planned-unit development, which probably will not occur without access to and from Route 2. It should be noted, though, that this area is also within the floodplain of the Alewife Brook, and any development would encroach upon this floodplain.

The Town of Belmont should only be impacted in a very minor manner due to the limited extent of the highway improvements in the Route 2/Lake Street interchange area and the established character of the area as a low-density residential neighborhood.

Impacts on existing development and community growth will be most apparent in the City of Cambridge as a result of the proposed highway improvements. Direct access to existing development along Route 2 will be eliminated as a safety measure and, as such, may adversely affect several highway-oriented businesses located there, including the two gasoline stations and a motel. However, replacement access to the rear of these commercial establishments along Route 2 eastbound will be provided by a proposed access road from Acorn Park Road and should not appreciably affect local community patronage of the restaurant and bowling alley located there, although the precise magnitude of the "damages" to all development which will result from elimination of the direct Route 2 access is yet to be determined. Similarly, damages due to relocation or removal of existing curb cuts in the vicinity of the improved Parkway/Rindge Avenue "dogleg" intersection, specifically to Babo's drive-in restaurant and Lehigh Metals, may also result, if the conduct of these businesses is impaired by the alterations.

The developed portions of the "Industrial Triangle" in Cambridge, which is bound by the Boston and Maine Railroad Fitchburg Branch Main Line, the Boston and Maine Railroad Freight Cutoff, and the Alewife Brook Parkway, is primarily of the heavy-industry type. The development potential of presently undeveloped lands within this triangle should be enhanced by the improved roadway access provided through the proposed Route 2-Rindge Avenue Extension connection and an improved Rindge Avenue/Alewife Brook Parkway intersection. Longer-term, higher-intensity uses could be induced to replace these heavy-industry uses, as a partial result of both improved highway accessibility and the proposed MBTA station/garage at Alewife. (Potential redevelopment of the "Industrial Triangle" and other areas in the Alewife Corridor is presently being examined as part of an urban design study for the City of Cambridge.) The proposed highway improvements should therefore have a beneficial effect, both short-term and long-term, on property values in the "Triangle" area due to the area's increased accessibility, which will be a direct benefit to the city's tax base.

II.3 CONSERVATION AND PRESERVATION

Natural Environment

Alewife Brook, Little River, Little Pond and the associated wetlands and ponds located in portions of the Alewife Brook Reservation provides habitats for waterfowl, upland birds and freshwater mammals. These wetland areas are highly diversified, with plant communities providing nesting and breeding sites, escape cover, and food supplies for waterfowl and upland birds in close proximity to each other.

The vegetation which exists by the Alewife Brook, Little River, and Little Pond is that commonly found in wetland areas in Massachusetts, with reed grass and cattail predominating in the marsh and swamp areas; wood shrubs and major vegetation such as sumac and blackberry, speckled alder, red maple, and slippery elm in the lowland areas; and goldenrod, milkweed, aster, and meadowsweet groundcover, and major vegetation such as sumac, gray birch, red maple, aspen, willow, oak, beech, and ash in the drier upland areas.

The types of wildlife occasionally found in portions of the Alewife Brook Reservation include the redwing blackbird, starling, swamp sparrow, pheasant, black duck, mallard, and wood duck in the marsh and swamp areas; and the gray squirrel, raccoon, rabbit, field sparrow, and goldfinch in the lowland and upland areas. Large populations of wildlife do not presently inhabit the Reservation.

The wetlands constitute a major portion of the Alewife Brook floodplain and are invaluable in reducing the peak flows of water which usually occur in the spring or fall of the year. The wetland vegetation is the only substantial vegetation in the area which adequately slows the floodwaters. This flooding is caused by a combination of factors: the flatness of the area, the presence of an impermeable layer of clay twenty to thirty feet below the surface, a high-water table in the area, and the fact that there are constrictions that limit flow capacities on the Alewife Brook further downstream. The soil and water table conditions greatly reduce the ability of the land to absorb water and the constrictions further downstream prevent water from flowing out of the Alewife Brook floodplain area, thus creating a potential flooding situation.

Encroachment of the highway improvements proposed as part of the Minimum-Build Alternative upon the floodplain of the Alewife Brook will be minimized by constructing the roadways on viaducts wherever required. Specifically, the new connection between Route 2 and the Rindge Avenue Extension is proposed to occur primarily on viaduct as it crosses the Alewife Brook Reservation north of the Boston and Maine Railroad's Freight Cutoff. Much of Route 2 itself, from west of the present bridge over the B&M's Bedford Branch to the Dewey-Almy Circle area, is also proposed to use a viaduct system. It is anticipated that approximately 1.2 acres of land will be removed from the floodplain, which represents less than 1 per cent of the total Alewife floodplain area. By comparison, these same roadways on embankment would require that 5.2 acres of land be removed from the floodplain for the surcharge condition and 4.2 acres for its final configuration. Adequate replacement floodwater storage areas do exist within the MDPW's right-of-way, and are planned for as part of the proposed project. By shifting Route 2, in the vicinity of the Bedford Branch of the Boston and Maine Railroad, to the south, and by constructing the roadways on viaduct, as described above, the removal of existing embankments to provide the required replacement flood storage areas will be possible.

The Minimum-Build Alternative may cause some impacts also to occur on existing vegetative resources beneath and adjacent to the viaduct due to the shadows cast by the elevated facility upon

the area, as well as from increased roadway-related pollutants. Some wildlife in the MDC Reservation area may also be adversely affected by increased noise and traffic motion, occasioned by the addition of a new roadway (Route 2 Connector) to the area. Possible impacts to the wildlife's food chain created by certain toxic compounds from increased roadway stormwater runoff may also occur. The aggregate impact of the Minimum-Build Alternative on the existing wildlife population, however, is anticipated to be slight, due to the scale of improvements relative to the No-Build condition, and due to the absence of large-scale wildlife populations themselves. Also, an Order of Conditions to be issued by the local conservation commissions will incorporate measures to minimize impacts to the wetland areas, and therefore, to existing wildlife habitats. Finally, no threatened or endangered species were found to exist in this area.

Publicly-Owned Open Spaces

The Alewife Brook Reservation (MDC) and the Thorndike Street Playground (Arlington) are the only publicly-owned open-space lands likely to be impacted by the proposed highway improvements.

The Alewife Brook Reservation can be described in terms of two contiguous areas, for purposes of review and in light of the MDC's own description of the land which is contained in an April 28, 1977 letter to the MDPW (Exhibit O in the Appendix). These areas are:

(1) Alewife Brook Reservation East. This area includes the Alewife Brook Parkway corridor itself, which extends from Concord Avenue in Cambridge to the Mystic Valley Parkway in Somerville. It also includes the Yates Pond area, bound by the Parkway, Route 2, and the Boston and Maine Railroad's Bedford Branch and Freight Cutoff; lastly, it includes the area just west of the Bedford Branch, north of the Freight Cut-off, south of Route 2, and generally east of a north-south line which includes the westerly boundary of the ADL parking area. This parking area is leased to ADL by the MDC.

(2) Alewife Brook Reservation West. This area includes the Little Pond, Little River, and the associated open-space areas west of the Reservation property described above. This area is generally bound by the Arthur D. Little property on the north, the Freight Cutoff on the south, and Belmont residential areas on the southwest and west. It also includes the Belmont Skating Rink, situated within the Route 2/Lake Street interchange.

The total area of the Alewife Brook Reservation (East and West combined) amounts to approximately 124 acres.

The Alewife Brook Parkway portion of the Alewife Brook Reservation East is used for a variety of trip purposes, chief of which are for commuting and for shopping and business access to adjacent commercial and industrial development. It is not restricted, like other MDC Parkways, to pleasure vehicles only. Between Concord Avenue and Dewey-Almy Circle, little to no abutting open-space exists within the Parkway Corridor. Northward from Dewey-Almy Circle, a linear open-space corridor exists, concentrated primarily on the westerly side of the Parkway and including the Alewife Brook.

The remaining area within the Alewife Brook Reservation East, generally located south of Route 2 between the ADL Complex and the Parkway, possesses both developed and open-space uses. The developed uses include the parking area leased by ADL from the MDC and the Boston and Maine Railroad trackage which crisscrosses or bounds the area. The open-space areas between these developed uses have been disturbed in varying degrees by man.

Unorganized activities such as walking and bicycling have been observed along the Parkway/Alewife Brook corridor north of Dewey-Almy Circle. Some occasional unorganized activities such as walking have also been observed in the Reservation East along the Little River in the vicinity of the ADL parking area.

The Alewife Brook Reservation West is composed primarily of open-space lands, with the skating rink at the westernmost end being the only improved facility located within its limits. Unorganized activities have been observed in this area, including walking, canoeing, birdwatching, and other activities passive in nature. There are no organized activities undertaken by the MDC in this area, nor are there any recreational facilities located here, with the single exception of the skating rink. This skating rink, which is located within the southeast portion of the Route 2/Lake Street interchange, has been inoperable since 1970; the paved area around this rink is being used as a "park-and-ride" facility for MBTA buses to Cambridge.

Portions of both the Alewife Brook Reservation East and West are also used as a conservation and flood-storage area, and as such, the acreage of floodplain displaced overlaps somewhat the acreage of Reservation open-space displaced. The Minimum-Build Alternative will displace land only from the Reservation East, not from the Reservation West. The Reservation East landtakings amount to approximately 2.9 acres, consisting of 2.8 acres for the direct connections from Route 2 to the Rindge Avenue Extension and for realignment of a portion of Route 2, and 0.1 acres of additional paved area within the Parkway corridor. This acreage represents approximately 2.3 per cent of the total area of the Alewife Brook Reservation. By comparison, if the viaduct portions of Route 2 and the Rindge Avenue Extension connector were instead placed on embankment, an additional 4.0 acres of Reservation East would be required for the surcharge condition and 3.0 acres for its final configuration.

Thorndike Street Playground is a 7.8-acre recreational field which is owned by the Town of Arlington and controlled by the Park Department. It is bound by the Mugar property to the north, the Boston and Maine Railroad's Bedford Branch to the east, Route 2 to the south, and the Mugar property to the west.

The playground is the only large open field in eastern Arlington, and as such, serves the recreational needs of a large district. With the exception of a paved basketball court, the playground is grass-covered and is used for sports such as football, soccer, volleyball, and other activities. Average daily usage during the summer months approximates 200 people. A significant portion of the playground is within the floodplain of the Alewife Brook area.

The proposed highway improvements will not require acquisition of any portions of the Thorndike Street Playground, as the improvements in this area have been shifted southward (i.e., away from) the playground area. The Minimum-Build Alternative, therefore, will not introduce any additional long-term impacts to the area over the No-Build condition. No temporary easements for construction will be required on the playground lands. Short-term impacts created by the construction of the highway improvements, such as increased noise, dust, and dirt, may be experienced at the playground. These impacts will be minimized by employing construction techniques to control the noise and the dust and dirt which may be blown into the air.

Privately-Owned Open Spaces

The two major vacant open spaces in the area are the Arthur D. Little, Inc. parcel in Belmont and Cambridge and the Mugar parcel in Arlington. The proposed access road from Acorn Park Road in Belmont to the rear of the commercial establishments along Route 2 eastbound will require the acquisition of approximately 1.2 acres of land owned either by Arthur D. Little, Inc. or by these commercial establishments, a portion of which is also floodplain storage area. The second major vacant parcel, the Mugar site, will not be permitted direct access from Route 2.

Historic Sites

The historical commissions of the communities of Cambridge, Arlington and Belmont, and also the Massachusetts Historical Commission, were consulted to identify sites of historical significance in the area of the proposed improvements. All sites identified by these commissions are sufficiently distant from the areas of proposed construction for the Minimum-Build such that no impact will result to these sites.

The State Archeologist was also consulted relative to the location of archeological sites in the Alewife corridor. No known archeological sites or potential archeological sites were identified by the State Archeologist in this area.

II.4 PUBLIC FACILITIES AND SERVICES

Religious, Health, and Educational Facilities

St. Jerome's Church, 201 Lake Street, Arlington, is the only religious institution that is located in the vicinity of the proposed project. The highway improvements, however, will have no impact upon this facility. There are no health facilities or educational facilities located close enough to the proposed construction site which would be impacted during or after completion of the project.

Utilities

There are numerous underground utilities located within the construction area along Route 2, the Alewife Brook Parkway, Rindge Avenue, and in the Industrial Triangle. Several of these utilities are considered major, such as:

- 66-inch MDC sewer,
- 48-inch MDC sewer,
- 26-inch gas main,
- 6-inch oil line, and
- 345-kv (high-voltage) power duct,

while other minor utilities, such as water mains and stormwater drains, are also scattered throughout. The relocation of these utilities will be avoided wherever possible. However, some utility relocations may be required to accommodate footings for viaducts and other structures. The extent and nature of these relocations will be determined during the final design stage of the project.

Public Services

Fire, police, ambulance, and other emergency services will be improved under this project due to improved access to the industrial/commercial portions of the area. Fire and police pre-emption devices will be installed at the proposed Alewife Brook Parkway/Route 2 and the Alewife Brook Parkway/Rindge Avenue intersections, which will allow emergency vehicles priority to pass through the intersections. Wider roadway widths will provide storage for vehicles which break down and will allow vehicles to pull over and permit emergency vehicles to pass through. Under present conditions, a vehicle which breaks down creates traffic tieups and inconveniences along the Parkway, due to the 10-foot travel lanes and absence of shoulders. Access to be used by emergency vehicles only is also possible from the viaduct of the Route 2/Rindge Avenue Extension inbound connector to the Arthur D. Little complex adjacent to Route 2, although it is not part of this project itself. The Cambridge Fire Department has identified this emergency access route as a desired element of future roadway improvements in the Alewife area. This new access would eliminate the present time-consuming route (i.e., via the Route 2/Lake Street interchange) used by emergency vehicles from Cambridge to respond to situations at ADL or the commercial establishments along Route 2.

II.5 COMMUNITY COHESION

The residential neighborhoods of Arlington, Belmont and Cambridge are located far enough from the proposed highway construction area so that there should be no major impacts in terms of fragmentation of neighborhood character or stability. In conjunction with the Minimum-Build Alternative and the proposed MBTA station/garage construction, improvements in pedestrian and bicycle access throughout the area will be realized, which should improve both community cohesiveness and accessibility. However, as noted in Section II.1, TRAFFIC SERVICE AND SAFETY, traffic congestion on the roadway network in the year 2000 under both the Minimum-Build and the No-Build Alternatives may effect increased traffic volumes on residential streets adjacent to Route 2/Alewife Brook Parkway as motorists attempt to avoid the congestion on these roadways. This increased neighborhood traffic could negatively impact the cohesiveness of the community. Again, a positive feature of the Minimum-Build Alternative in this regard is the improved Parkway/ Rindge Avenue "dogleg" intersection, which has been designed so as to prohibit encroachment of Parkway southbound traffic and Rindge Avenue Extension traffic into Rindge Avenue and the North Cambridge neighborhood.

II.6 DISPLACEMENT OF PEOPLE AND BUSINESSES

As the proposed improvements are located primarily within the existing roadway rights-of-way, displacement of residents or businesses will not occur as a direct result of this project. [Business displacements within the area bound by the Alewife Brook Parkway on the east, Rindge Avenue Extension on the south, the Boston and Maine Railroad Bedford Branch on the west, and the B&M Railroad Freight Cutoff on the north are attributable to the proposed MBTA station/garage, and would occur independent of implementation of the Minimum-Build Alternative. These displacements have been detailed in UMTA's draft and final Environmental Impact Statements for extension of the Red Line from Harvard Square to Arlington Heights.] However, damages to business enterprises adjacent to Route 2 eastbound, because of loss of direct access from Route 2, especially highly access-dependent businesses such as the two gasoline stations, may result in full takings, and subsequent displacements, of these business parcels. Similarly, damages to Babo's drive-in restaurant, occasioned by removal or relocation of curb cuts in conjunction with the improved Parkway/Rindge Avenue intersection, could also result in possible full takings and displacements.

Business land acquisition will be required to implement the proposed improvements, as presented in Table 7. These statistics include partial acquisition of parcels (land only) on which the commercial establishments along the south side of Route 2 are located. Industrial land acquisition and commercial land acquisition

Table 7

BUSINESS LAND-ACQUISITION REQUIREMENTS

	INDUSTRIAL					COMMERCIAL					TOTAL				
Alt.	Land Area (Acres)	No. of Structures	Total Floor Space (SF)	No. of Businesses	No. of Jobs	Land Area (Acres)	No. of Structures	Total Floor Space (SF)	No. of Businesses	No. of Jobs	Land Area (Acres)	No. of Structures	Total Floor Space (SF)	No. of Businesses	No. of Jobs
No-Build	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum-Build	4.7	0	0	0	0	1.2	0	0	0	0	5.9	0	0	0	0

NOTES:

(1) Developed parcel acquisitions based on existing uses; if vacant lands, acquisitions based on current zoning.

(2) Land acquisitions for MBTA station/garage not included.

(3) Does not include possible acquisition of entire parcels due to damages, which are indeterminable at this time.

Table 8

TAX LOSSES AND LAND-ACQUISITION COSTS DUE TO DISPLACEMENT

	TAX LOSS ($)					*ACQUISITION COSTS ($)				
Alternative	Res.	Comm.	Ind.	Public	Total	Res.	Comm.	Ind.	Public	Total
No-Build	0	0	0	0	0	0	0	0	0	0
Minimum-Build	0	6,000	23,000	0	29,000	0	74,500	585,000	348,500**	1,008,000

*Based on adjusted valuations; does not include property damages, relocation assistance, or recent property appraisals.

**Includes Alewife Brook Reservation, whose "acquisition cost" as listed here was based on adjusted valuations for adjacent privately-owned open space, not on a recent property appraisal.

under the Minimum-Build Alternative would amount to 4.7 acres and 1.2 acres respectively, for a total of 5.9 acres of business land acquisition.

Land acquisition costs are listed in Table 8. The estimated total acquisition costs, $1,008,000, were derived from the assessed valuations of the affected properties in fiscal year 1974-75, adjusted to full market value, and do not reflect recent property appraisals or damages. Associated with the loss of industrial and commercial properties is the resultant tax revenue losses to the communities of Cambridge, Arlington and Belmont. The estimated total tax revenue loss, approximately $29,000, is based on the 1974-75 adjusted property valuations in the area. This impact is minor in comparison to the total taxable property in the three communities, and at a minimum Cambridge's tax losses could potentially be offset by increased property values and an expanded tax base created by anticipated new development in the "Industrial Triangle," which should be encouraged by the improved accessibility.

The overall impact of transportation improvements in the past has generally been a tendency to cause a net increase in total land values adjacent to the improvements in the long term, and to create greater economic activity as a result of the increased accessibility. The significance of this impact is anticipated to be relatively minor on the Alewife Corridor as a whole due to the limited scope of the proposed highway improvements, and confined primarily to Cambridge's "Industrial Triangle" area.

II.7 NOISE, AIR AND WATER QUALITY

Noise

Due to the capacity constraints imposed on the proposed new roadway system, and the similarity between existing and future vehicle operating speeds and truck percentages, traffic noise associated with estimated future traffic on the system is expected to be similar to noise generated by existing (1975) traffic. Sensitive noise receptors in the area, such as the Rindge Towers apartment complex adjacent to the Alewife Brook Parkway in Cambridge and the residences near Route 2 in Arlington, will experience an increase in traffic noise levels in the year 2000 of approximately 2 decibels (dB) over the existing (1975) conditions. Under ordinary listening conditions, a human observer will not detect a difference of 2 dB in a time-varying noise source such as traffic noise. However, noise levels in the vicinity of the Rindge Towers complex will likely decrease in the future due to the provision of direct access to the "Industrial Triangle" from Route 2, which will divert truck traffic away from this sensitive receptor.

Air Quality

Quantities of air pollutants emitted by highway vehicles, i.e., carbon monoxide (CO), hydrocarbons (HC), and oxides of

...rogen (NO_x), depend largely on traffic volumes and flow conditions. The highest concentrations from motor vehicles are experienced following cold-engine starts or during low-speed or idle conditions, typical of congested roadways during peak-hour conditions. The proposed highway improvements are more safety-related than capacity-related, and as such will not improve traffic flows and, hence, should not alter air quality significantly. Compliance with strict federal requirements for pollutant concentrations from new automobiles should be more of a benefit to existing air quality in the area of the proposed highway improvements than will the improvements themselves.

Water Quality

Highways affect water quality primarily through stormwater runoff, which collects pollutants such as heavy metals, hydrocarbons, cyanides, biphenols, etc., and transports them to local bodies of water. The application of roadway salt (sodium chloride) as a deicing agent also has an adverse effect on water quality--the quantity of salt used being directly proportional to the amount of paved roadway in use. Stormwater runoff is related to the amount of impervious or paved area that exists. Within the limits of the proposed highway improvements, the quantity of paved roadway will increase by approximately 50 per cent over the No-Build conditions, with a subsequent increase in runoff. This increase in runoff is relatively insignificant in comparison to the total impervious area contained within the watershed area of the nearby water bodies, the watershed area encompassing approximately 5300 acres of urbanized lands. The provision of replacement flood storage areas, in addition to reducing flood peaks, will also allow time for the natural regeneration of runoff waters, so that their impact on the water bodies in the area will be minimized.

II.8 ESTHETICS

A definite impact upon the visual environment of the area will result from the proposed project due to the introduction of new structures and additional paved areas. This impact, however, may not necessarily be adverse. The ability to create a pleasing view of the road as well as from the road requires careful coordination of roadway design, landscaping, structural design, and natural area preservation.

In order to minimize encroachment of the proposed roadway improvements on the floodplain and the Alewife Brook Reservation, a portion of Route 2 and the connector roadways from Route 2 to Rindge Avenue Extension will be constructed on viaduct. These structures, as well as the new bridge over the Boston and Maine Railroad's Freight Cutoff, will be designed to be architecturally pleasing, to enhance the topographical characteristics of the area, and to avoid unnecessary massiveness.

Landscaping of the area will employ the use of naturally shaped embankments for screening or enframement; grass, shrubs and trees for screening, dust control, noise abatement, and reduction of headlight glare; and the use of esthetically designed retaining walls to minimize cut-and-fill areas wherever these measures are deemed necessary and appropriate.

Overall, the proposed improvements along Route 2 and the Alewife Brook Parkway will not appreciably alter the visual scale of these facilities, and in general will result in improvements to the esthetic qualities over and above their present "No-Build" appearance. The proposed Route 2/Rindge Avenue Extension connection will add an additional roadway to the area. However, the scale of this roadway is consistent with the scale of the adjacent improved Alewife Brook Parkway and the proposed MBTA station/garage at Alewife. Furthermore, much of its visual scale effects, including station/garage grade-separated and at-grade access, will be confined to the "Industrial Triangle" area south of the Boston and Maine Railroad's Freight Cutoff.

II.9 COST

The estimated project cost for the Minimum-Build Alternative is approximately $13.9 Million. This estimate includes property acquisition costs totaling approximately $1.0 Million, although relocation assistance and possible damages are not included. The construction costs can be broken down further as:

	Cost (Million)
o Route 2-Alewife Brook Parkway Main Line Improvements	$ 7.9
o Parkway/Rindge Avenue Intersection Improvements	0.7
o Lake Street Interchange-Acorn Park Road Improvements	0.5
o Route 2-Rindge Avenue Extension Connectors	3.5
o Railroad relocations	0.3
Total:	$12.9

II.10 PUBLIC REACTION

As described in Section I.2, SUMMARY OF IMPROVEMENT DEVELOPMENT/EVALUATION PROCESS, of this EOS Update, considerable public interaction has occurred on this project, the participatory process including numerous informational meetings with specific public and

private interest groups and agency officials, weekly or biweekly meetings with a special citizens' advisory group (the Alewife Task Force), and three public meetings held for the general public. Alternatives have been proposed, developed, evaluated, modified, and rejected--all with public inputs. The end product of this process has been selection of the Minimum-Build Alternative to be carried forward by the MDPW as its proposed course of action.

Public reaction to this alternative can best be described as mixed. It embraces operational and design features supported by some groups and criticized by others. The single design feature supported by most groups is the connection between Route 2 and the Rindge Avenue Extension. This new connection provides needed direct access to the proposed MBTA station/garage and Cambridge's "Industrial Triangle." Major areas of public disagreement have included grade-separated versus at-grade treatment of the Route 2/Alewife Brook Parkway (i.e., Dewey-Almy Circle) and Rindge Avenue/Alewife Brook Parkway intersections, the major arguments being facility scale and resultant impact (pro at-grade) versus needed traffic service (pro grade-separation).

Because opposition towards a major-build roadway alternative has intensified toward the end of the post-EOS alternatives evaluation period of this project, the Massachusetts Executive Office of Transportation and Construction and the MDPW have decided in favor of the Minimum-Build Alternative. It represents an improvement scheme which the state feels possesses characteristics acceptable to a broadbased segment of the public for a roadway project in this corridor. Also, it is consistent with clear state transportation policy (i.e., emphasis on commutation by public transportation rather than the private automobile) that there is to be no increase in through-traffic roadway capacity within the Alewife Corridor. The intent of this project, namely improved safety and local access in support of existing and proposed new land uses (including the MBTA Red Line station/garage) is therefore met by the Minimum-Build Alternative, and public reaction in preference to this proposed project is consistent with state policy as well as project objectives.

III ANALYSIS OF POTENTIAL SECTION 4(f) AREAS

III.1 GENERAL

The proposed course of action, called the Minimum-Build Alternative, is described as follows:

(1) Elimination of direct access to abutting land-use development on both sides of Route 2 (Concord Turnpike), and reconstruction and minor relocation of Route 2 between the Lake Street interchange and Dewey-Almy Circle. Provision of replacement access to southside Route 2 development via a connection from Acorn Park Road.

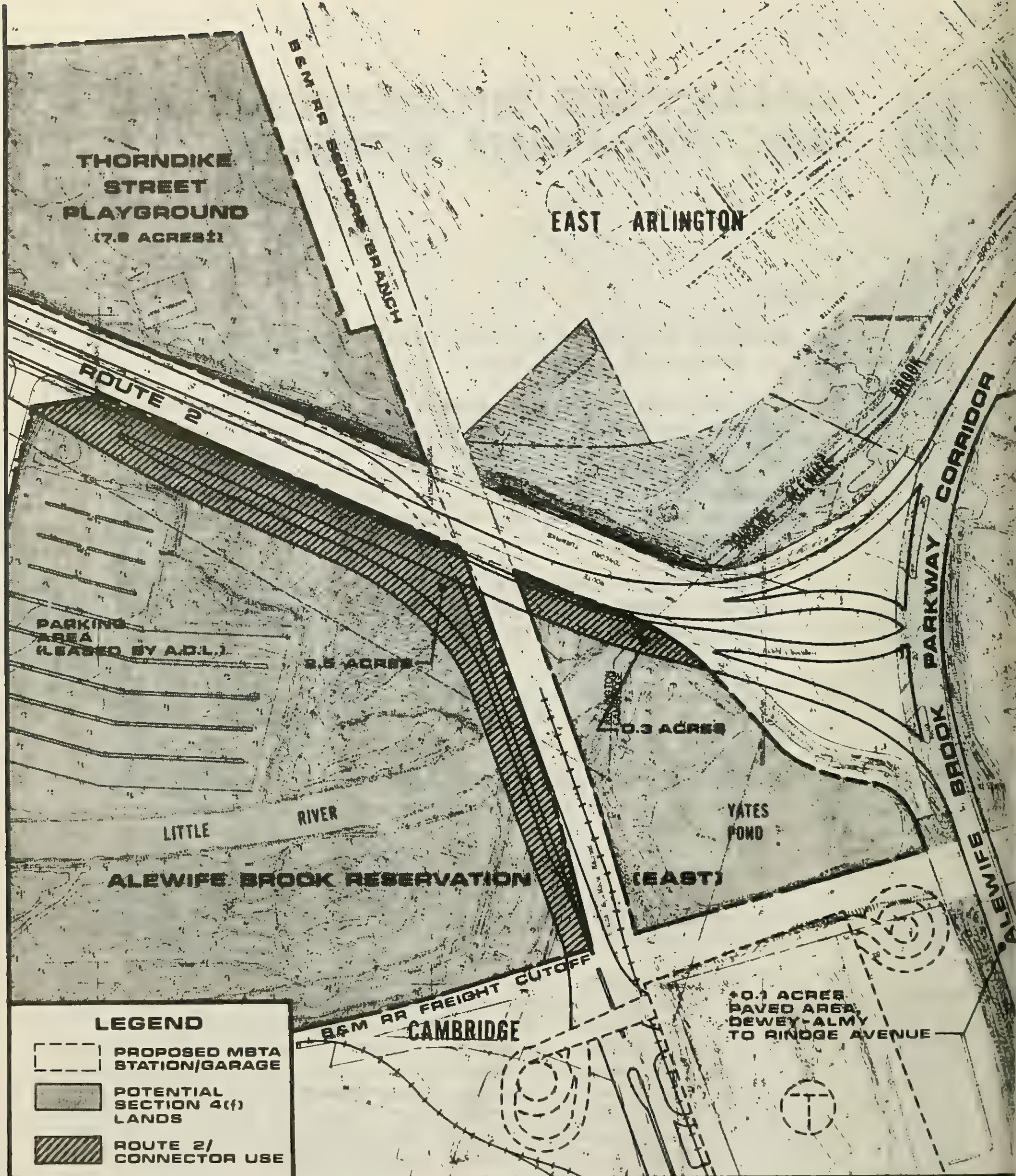
(2) Direct roadway connections between Route 2 and the Rindge Avenue Extension, including access to the proposed MBTA Red Line Extension station/garage at Alewife.

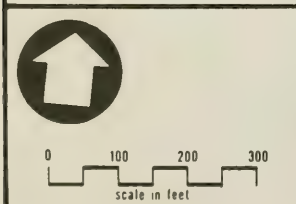
(3) Replacement of the Dewey-Almy rotary at Route 2 and the Alewife Brook Parkway with an at-grade, signalized and channelized "T"-intersection.

(4) Replacement of the substandard bridge over the Boston and Maine Railroad Freight Cutoff on the Alewife Brook Parkway.

(5) Improvement of the existing at-grade, signalized intersection of the Alewife Brook Parkway and Rindge Avenue through realignment, new signalization, and channelization.

Two potential Section 4(f) lands were identified to be within the general area of the improvements proposed by the Minimum-Build Alternative: the Alewife Brook Reservation in Belmont, Cambridge and Arlington, and the Thorndike Street Payground in Arlington. This section of the Environmental Overview Summary Update constitutes a Section 4(f) analysis which examines these properties and their relation to the Minimum-Build Alternative. Figure 5 depicts the Minimum-Build Alternative and its relation to those portions of the Alewife Brook Reservation and Thorndike Street Playground which could be impacted by it.





F. S. & T. INC. 1977

Figure 5

INVOLVEMENT OF POTENTIAL SECTION 4(f) LANDS- MINIMUM BUILD ALTERNATIVE

III.2 ALTERNATIVES ANALYSIS

More than forty roadway improvement alternatives or variations of alternatives were evaluated before selection of the Minimum-Build Alternative as the proposed course of action. These alternatives included major relocations of roadways in the interest of finding a prudent and feasible alternative to the proposed course of action. These alternatives were found to be viable from an engineering viewpoint, but their impacts on the communities and the environment, together with lack of broadbased public support and high construction and land acquisition costs, led the MDPW to reject these alternatives as possible prudent and feasible alternatives. No improvement alternative was found that met project objectives and avoided impacts to the area's potential Section 4(f) lands.

In evaluating these alternatives, numerous factors were considered, including safety, capacity, design standards, right-of-way requirements, effects on businesses and residents including relocation of same, ecological effects, regional and community growth effects, and other social and environmental effects. Throughout this study, the proposed extension of the Massachusetts Bay Transportation Authority's Red Line rapid transit facilities from Harvard Square to Arlington Heights, with a station and an approximately 2000-car parking facility at Alewife, was also considered with a view to providing an efficient interface between the highway modes and the rail rapid transit mode.

The No-Build Alternative, as an alternative to the use of potential Section 4(f) land, was also closely examined. As should be apparent, however, in the detailed alternatives analysis in Sections I and II of this document and Sections III and IV of the final <u>Environmental Overview Summary</u> (August 1975), the No-Build Alternative can not be considered a feasible and prudent alternative. Most importantly, the No-Build Alternative does not meet any of the three project objectives, namely: (1) the improvement of vehicular and pedestrian safety in the area, (2) the provision of improved access to adjacent development, particularly the so-called "Industrial Triangle" in Cambridge, and (3) the provision of improved pedestrian and vehicular access to the MBTA's planned station/garage at Alewife. (As stated previously in Section I of this document, the achievement by any alternative, including the No-Build, of the third project objective is dependent upon the proposed UMTA/MBTA program for the Red Line Extension. Regardless of whether the Red Line project is implemented, the MDPW would desire to proceed with roadway improvements which meet the other two project objectives.) In addition, the No-Build Alternative fails to meet other objectives such as the replacement of a substandard, unsafe Parkway bridge structure and the desire to improve or create recreational opportunities in the area. The No-Build Alternative calls for a retention of the status quo. That status quo is, today, an unsatisfactory situation and can be expected to deteriorate further in the future.

The following section describes in more detail the Alewife Brook Reservation and the Thorndike Street Playground, and the

impacts which the Minimum-Build Alternative will have on each, including discussions of feasible and prudent alternatives and measures to minimize harm.

III.3 POTENTIAL SECTION 4(f) LANDS

Two properties in the immediate vicinity of the improvements proposed as part of the Minimum-Build Alternative have been identified as potential Section 4(f) lands. They are the Alewife Brook Reservation, under the jurisdiction of the Metropolitan District Commission, and the Thorndike Street Playground, under the jurisdiction of the Town of Arlington. A November 7, 1972 letter from the Arlington Board of Park Commissioners established that the Thorndike Street Playground is a significant local park. An April 28, 1977 letter from the Commissioner of the MDC stated that the portion of the Alewife Brook Reservation which is affected by the proposed project is not significant within the meaning of Section 4(f). Copies of these two letters are shown as Exhibits N and O in the Appendix.

While awaiting official response from the MDC and the Town of Arlington, the Department and its consultant have made every effort to avoid or minimize harm to both properties in designing the various alternatives. A discussion of each property follows.

Alewife Brook Reservation

General Description. As stated previously in Section II of this document, the Alewife Brook Reservation can be described in terms of two contiguous areas, for purposes of review and in light of the description of the Reservation land contained in the MDC's April 28, 1977 letter (Exhibit O in the Appendix). These areas are:

(1) Alewife Brook Reservation East. This area includes the Alewife Brook Parkway corridor, which extends from Concord Avenue in Cambridge to the Mystic Valley Parkway in Somerville. It also includes the Yates Pond area, bound by the Parkway, Route 2, and the Boston and Maine Railroad's Bedford Branch and Freight Cutoff; lastly, it includes the area just west of the Bedford Branch, north of the Freight Cutoff, south of Route 2, and generally east of a north-south line which includes the westerly boundary of the ADL parking area. This parking area is leased to ADL by the MDC. As noted in the MDC's letter of April 28, 1977, this portion of the Reservation is characterized by the transportation uses which predominate in this area.

(2) Alewife Brook Reservation West. This area includes the Little Pond, Little River, and the associated open-space areas west of the Alewife Brook Reservation East, as described above. This area is generally bound by the Arthur D. Little

property on the north, the Freight Cutoff on the south, and Belmont residential areas on the southwest and west. It also includes the Belmont Skating Rink, situated within the Route 2/Lake Street interchange.

The total area of the Alewife Brook Reservation (East and West combined) amounts to approximately 124 acres.

Historical Context. The catalyst for the acquisition of the entire Alewife Brook Reservation was a malaria epidemic in the surrounding communities, caused by unsanitary conditions in the Alewife marshes. In order to eliminate the malarial breeding-grounds, a State Board of Health Report to the Legislature in 1906 recommended the acquisition of these lands. Subsequently, utilizing the so-called Boulevards Act, the Metropolitan Parks Commission (the MDC's predecessor) acquired the lands from the mouth of the Alewife Brook at the Mystic River to the Little and Spy Ponds in Belmont and Arlington. This was a linear distance of approximately 2.5 miles. The width of the landtakings varied between approximately 200 and 1000 feet (average width approximately 400 feet) and was governed by the plan of sanitation for the malaria problem. In addition, the land, having been acquired under the Boulevard Act, was to be the site of a "parkway" which would serve to provide a road connection between the Mystic River area to the north and the Fresh Pond-Charles River area to the south. Due to subsequent redesigns of the roadway, it was built further east on its present alignment. This alignment left undeveloped a parcel of land to the west which remains as open space today.

While the Commission continues to exercise jurisdiction over the Alewife lands, there exists legislation which reserves for the MBTA transit program the bulk of the land in the area which may be affected by the proposed transportation projects. Specifically, Chapter 491 of the Acts of 1951, as amended by Chapter 441 of 1960 and Chapter 618 of 1970, reserve 52 acres of MDC land in the Alewife area for transportation use, subject to further legislative action upon finalization of plans for transportation projects. This reserved area lies west of the Boston and Maine Railroad's Lexington Branch (also known as the Bedford Branch) and runs up to, but does not include, Little Pond.

Alewife Brook Reservation East. The Alewife Brook Parkway corridor itself within the Alewife project area is used for a variety of trip purposes, chief of which are for commuting and for shopping and business access to adjacent commercial and industrial development. It is not restricted, like other MDC Parkways, to pleasure vehicles only. Between Concord Avenue and Dewey-Almy Circle, little to no abutting open space exists within the Parkway corridor. Northward from Dewey-Almy Circle, a linear open-space corridor exists, concentrated primarily on the westerly side of the Parkway, and it includes the Alewife Brook (see Figure 5).

The remaining portion of the Alewife Brook Reservation East, generally located south of Route 2, between the ADL Complex and the Parkway, possesses both developed and open-space uses. The developed uses include the parking area leased by ADL from the MDC and the Boston and Maine Railroad trackage which crisscrosses or bounds the area. The open-space areas between these developed uses have been disturbed in varying degrees by man. Being mostly lowland, reed grass, cattail, sumac, blackberry, and red maple are the major forms of vegetation found in this area. Wildlife found there includes the redwing blackbird, starling, swamp sparrow, pheasant, duck, gray squirrel, rabbit, field sparrow, and goldfinch.

Unorganized activities such as walking and bicycling have been observed along the Parkway/Alewife Brook corridor north of Dewey-Almy Circle. Some occasional unorganized activities such as walking have also been observed in the Reservation East along the Little River in the vicinity of the ADL parking area.

Alewife Brook Reservation West. This portion of the Reservation is composed primarily of open-space lands, with the skating rink at the westernmost end being the only improved facility located within its limits. Unorganized activities have been observed in this area, including walking, birdwatching, and other activities passive in nature. There are no organized activities undertaken by the MDC in this area, nor are there any recreational facilities located here, with the single exception of the skating rink. This rink, which is located within the southeast portion of the Route 2/ Lake Street interchange, has been inoperable since 1970, and the paved parking area surrounding the rink is used as a "park-and-ride" facility for MBTA buses running to and from Cambridge.

Access to the Reservation West's open-space lands is limited, as there are no official roads entering the Reservation. Access is gained generally by foot, through private property, including the Arthur D. Little, Inc. property, along the Boston and Maine Railroad's right-of-way, or by local paths, mostly on private property, in Cambridge or Belmont.

The wetland and upland areas of the Reservation West provide habitats for a variety of plants and animals. Wildlife found in the Alewife Brook Reservation West includes the redwing blackbird, starling, swamp sparrow, pheasant, duck, gray squirrel, rabbit, field sparrow, and goldfinch. Reed grass and cattail are the predominating vegetation in the marsh and swamp areas. Sumac, blackberry, speckled alder, red maple, and slippery elm are found in the lowland areas; and goldenrod, milkweed, aster, and meadowsweet groundcover, and gray birch, red maple, aspen, willow, oak, beech, and ash trees are found in the drier upland areas.

Impacts of Minimum-Build Alternative. The Minimum-Build Alternative will impact the Alewife Brook Reservation East only, as shown in Figure 5. With reference to Figure 5, the realignment of Route 2 west of Dewey-Almy Circle and the direct connection between Route 2 and the Rindge Avenue Extension will be accomplished mostly on viaduct in the vicinity of the Alewife Brook Reservation East, and will require use of Reservation lands amounting to 2.9

acres, consisting of 2.5 acres west of the Bedford Branch and south of Route 2, 0.3 acres in the Yates Pond area, and an additional 0.1 acres of paved area within the Parkway Corridor itself. This use represents approximately 2.3 per cent of the total area of the entire Alewife Brook Reservation.

These improvements may result in some long-term impacts on existing Reservation vegetative resources beneath and adjacent to the viaduct due to the shadows cast by the elevated facility, as well as roadway-related pollutants contained in stormwater runoff. Wildlife which may exist in this area may also be impacted somewhat, long-term, due to traffic motion and increased noise, as well as the possible addition of toxic compounds into area waterbodies from the increased runoff. The aggregate long-term vegetative and wildlife impacts of the Minimum-Build Alternative on the Reservation East, however, is anticipated to be slight in this area, due to the already present roadway effects of Route 2 and the Alewife Brook Parkway, the railroad effects from the Boston and Maine Railroad's Bedford Branch and Freight Cutoff, and the effects from Alewife Brook Parkway commercial activity and Rindge Avenue Extension industrial activity.

As noted previously, only occasional informal or passive recreational-type uses were observed to exist in this area. Factors contributing to this include the absence of defined pathways for pedestrians and bicyclists, the difficulty in gaining access to the area, the close proximity of adjacent area highway and rail facilities, existing land-use activities which tend to detract from the area's natural features, and the presence of debris throughout the area which has either been directly discarded in the area or has washed downstream from the upper reaches of the Little River. Therefore, the impact of the Minimum-Build Alternative, at least on present informal activities in this area, should be slight. Indeed, as will be described in the next section, positive measures to enhance informal use of this area will be possible as a result of the proposed improvements.

Short-term impacts created by the construction of the roadway improvements, such as noise, dust, dirt and other disturbances, will also result.

Measures to Minimize Harm. To minimize encroachment on the Alewife Brook Reservation East and the floodplain, portions of the roadway improvements in this area have been proposed to be located on viaduct. These same improvements on embankment would require an additional 4.0 acres of the Alewife Brook Reservation for the surcharge condition, and 3.0 acres for the final roadway embankment configuration. The open areas that will result beneath the Route 2 viaduct will allow for the provision of replacement flood-storage areas. Both viaducts have the potential for providing pedestrian and bicycle paths for passage through the Reservation across (beneath) the area's two major roadways. The potential for improved pedestrian/bicyclist access through this portion of the Reservation area is an oft-stated objective of the Alewife Task Force and other groups, as part of a "Linear Park" improvement in the area.

The viaduct structures will be designed to be architecturally pleasing, consistent with the area's topographic features, and to avoid massiveness. Landscaping will restore disturbed areas to as close to their preconstruction condition and appearance as possible, and in many cases, new plantings will improve the area's natural features over and above its existing No-Build appearance. An important mitigative and enhancement aspect of the Route 2 structure is the replacement of the constrictive 15-foot by 10-foot box culvert carrying the Alewife Brook (and Little River) waters beneath the Route 2 embankment by a larger open channel beneath the proposed Route 2 viaduct. Removal of this constriction will help to reduce the possibility of future flooding within the Alewife Brook floodplain during peak flow periods due to the improved water flow. A mitigative feature of the Route 2 to Rindge Avenue Extension connection is that it has been located to overlap with, as much as possible, the existing right-of-way of the Boston and Maine Railroad's Bedford Branch and the proposed MBTA Red Line tunnel alignment to Arlington Center, to minimize both long-term and short-term (construction) impacts on the Reservation.

In addition, it has been the policy of the MDPW to compensate other state agencies for land damages or acquisition. This policy allows for either monetary payments or for in-kind replacement of acquired or damaged lands. Because Massachusetts law requires that monies reverting to state agencies as a result of such payments be returned to the Commonwealth through the General Fund, the agencies often request that compensation for property damages assume the form of replacement property. The Executive Office of Transportation and Construction has made a commitment to the MDC that this policy will be followed in the case of this project. It has also committed itself and the MDPW to participate in appropriate joint development and environmental enhancement of MDC properties affected by the project, including such considerations as trails, bikeways, etc. Finally, it has committed itself and the MDPW to work cooperatively with the MDC on hydrology issues and to coordinate project design work with MDC design staff.

Short-term construction impacts within the Reservation East will be minimized by incorporating into the construction specifications provisions related to the control of working hours, application of dust control agents such as calcium chloride, control of stormwater runoff, storage of construction materials, backfilling or covering excavations at the end of the working day, etc. It is also anticipated that the Order of Conditions established at a later stage for this project by the Conservation Commissions of Cambridge and Arlington under the Massachusetts Wetlands Protection Act, General Laws Chapter 131, Section 40, will also include specific mitigative measures to minimize harm to the Reservation's wetlands.

Feasible and Prudent Alternative. With reference to Figure 5, the existing right-of-way width of Route 2 as it passes between the Thorndike Street Playground and the Alewife Brook Reservation East is 100 feet. Three general locational options for providing a direct connection to Rindge Avenue Extension and the proposed MBTA station/garage were examined as part of various improvement alternatives in this study:

(1) Direct connection from Route 2 in the vicinity of Lake Street via the rear of the Arthur D. Little, Inc. complex.

(2) Direct connection from Route 2 just west of Dewey-Almy Circle in the vicinity of the Boston and Maine Railroad's Bedford Branch (as proposed).

(3) Direct connection from Route 2 south of Dewey-Almy Circle and west of and paralleling the Alewife Brook Parkway to Rindge Avenue.

The first locational option required substantially more encroachment into the Alewife Brook Reservation, particularly the western portion in the vicinity of the Little Pond and the Little River, and had substantially greater environmental impacts and costs than did the other two locational options. It was rejected as not being a feasible and prudent option.

The second locational option constitutes part of the Minimum-Build Alternative, and represents the "minimum-path" or shortest distance connection possible between Route 2 and the Rindge Avenue Extension, and also overlaps to the extent possible with the Boston and Maine Railroad's Bedford Branch right-of-way and the proposed Red Line tunnel right-of-way to Arlington Center, to minimize Reservation land-acquisition requirements.

The third locational option would require substantially the same, if not more, encroachment on the Alewife Brook Reservation as the second option because of the requirement of access ramps parallel to Route 2 eastward to Dewey-Almy Circle, and then parallel to the Parkway southward to the Rindge Avenue/Rindge Avenue Extension area. This locational option would pass between the Thorndike Street Playground and the Alewife Brook Reservation East, as would the second locational option, and because of encroachment, would have the same disruptive effects on the Reservation and the floodplain as the second option and greater disruptive effects on the Parkway corridor. For this reason, it was rejected as not being a feasible and prudent alternative to the second locational option.

The passage of the proposed Route 2 to Rindge Avenue Extension connection (including access to the proposed MBTA station/garage) through the Alewife Brook Reservation East, therefore, is unavoidable. The manner of connection as exemplified by the Minimum-Build Alternative effects the least impact on the Reservation and the surrounding environment of the three general locational options. To further minimize this improvement's encroachment on the Reservation would require the shifting of Route 2 in this area to the north, which would result in encroachment into the Thorndike Street Playground, itself also a potential Section 4(f) land and an active recreational area.

Avoidance of encroachment into this second potential Section 4(f) land has necessitated a minor shift in the alignment of Route 2 to the south, to allow for the westbound connection to

Route 2 from Rindge Avenue Extension to occur within the existing Route 2 right-of-way. The cross-section of Route 2 in this area has been kept to the minimum necessary to afford efficient and safe connections from Rindge Avenue Extension to Route 2 and a proper and safe transition between Route 2's existing four-lane cross-section to the east at Dewey-Almy Circle and its eight-lane cross-section to the west of Lake Street.

Statement as to Significance from Metropolitan District Commission. On September 17, 1975, the MDPW submitted a letter to the Metropolitan District Commission, requesting a response from the Commission of Section 4(f) significance of the Alewife Brook Reservation, the MDC skating rink at Lake Street, the Alewife Brook Parkway, and the Fresh Pond Parkway (see Exhibit L: Letter to Mr. John F. Snedeker, Commissioner, MDC from Mr. Robert T. Tierney, Chief Engineer, MDPW, dated September 17, 1975). As mentioned earlier, an April 28, 1977 response was received from the MDC finding the portion of the Reservation referred to as the Reservation East in this document to be insignificant for purposes of Section 4(f). A copy of this response is shown as Exhibit O in the Appendix.

Thorndike Street Playground

Description. The Thorndike Street Playground is located in southeastern Arlington adjacent to the north side of Route 2 and is a 7.8-acre recreational facility which is owned by the Town of Arlington and controlled by the Parks and Recreation Commission. It is bound by the Mugar property to the north, the Boston and Maine Railroad's Bedford Branch to the east, Route 2 to the south, and the Mugar property to the west.

The facility is the only large open field found in southeastern Arlington, and as such, serves the recreational needs of a large district. The playground is grass-covered, with the exception of a paved basketball court, and is used for various field sports such as football, baseball, soccer, and volleyball. Little League baseball, the Men's Softball League, and the Suburban Girl's Softball League (five nights a week from May through August) are supervised programs using the fields during the summer months. High school football and soccer teams use the fields during the fall months. Average daily attendance at the facility during the summer months approaches 200 people.

The facility is fairly accessible via Thorndike Street to the east or Margaret Street to the north. These two streets are joined by an unpaved access road and parking area which parallels the eastern boundary of the playground. A significant portion of the Thorndike Street Playground is located within the floodplain of the Little River and the Alewife Brook, as identified by a hydrology study completed in 1962 by CE Maguire, Inc.

Impacts of Minimum-Build Alternative. The highway-related improvements proposed under the Minimum-Build Alternative will have minor, if any, long-term impacts on the facility's use because no

playground lands will be acquired or used for its implementation. The closest traffic will come to the playground resulting from the highway improvements will be from vehicles using the connector from Rindge Avenue Extension to Route 2 westbound. This traffic, however, will be no closer to the facility than the present mainline traffic on Route 2 westbound. The traffic volumes on the connector to Route 2 westbound will also be less than either present (1975) or future (2000) mainline volumes on westbound Route 2, which may result in downward changes, if any, in noise levels and air pollution levels at the Playground attributable to Route 2 traffic.

Some short-term impacts on the playground may result from the construction activity itself. Noise, dust and dirt may affect the playground's usage, particularly during the dry summer months.

Measures to Minimize Harm. The principal measure to minimize long-term harm to the Thorndike Street Playground is the shifting of the alignment of Route 2 in this area southward so that the Rindge Avenue Extension connection to Route 2 westbound will not encroach on the Playground. As stated previously, the connector itself will be located within existing Route 2 right-of-way, and will follow approximately the same alignment as the existing Route 2 westbound roadway. Landscaping and plantings will be employed to the extent possible to minimize further visual encroachment on the Playground.

Measures to minimize short-term construction impacts will be incorporated into the construction specifications, and will include necessary requirements related to control of working hours, application of dust control agents such as calcium chloride, control of stormwater runoff, storage of construction materials, backfilling or covering excavations at the end of the working day, etc. Because the Playground is part of the Alewife Brook floodplain, an Order of Conditions will be issued by the Arlington Conservation Commission under the Massachusetts Wetlands Protection Act, which should also contain specific measures to minimize construction impacts.

Feasible and Prudent Alternatives. Since the Minimum-Build Alternative does not encroach on the Thorndike Street Playground and does not involve roadway construction in closer proximity than existing Route 2, a feasible and prudent alternative to the use of the Thorndike Street Playground is the Minimum-Build Alternative.

Statement as to Significance from the Town of Arlington. On September 3, 1975, the MDPW submitted a letter to the Arlington Parks and Recreation Commission requesting a response from the Commission of Section 4(f) significance of the Thorndike Street Playground and the Magnolia Street Playground (see Exhibit M: Letter to Mr. James Fowler, Chairman, Parks and Recreation Commission, Arlington from Mr. Robert T. Tierney, Chief Engineer, MDPW, dated September 3, 1975). At the time of preparation of this environmental document, a response from the Town of Arlington had not yet been received by the MDPW. As mentioned earlier, however, on November 7, 1972, a letter from the Arlington Board of Park Commissioners was received by the Boston Transportation Planning Review stating that the Thorndike Street Playground is a significant local park. A copy of this letter is shown as Exhibit N in the Appendix.

III.4 SUMMARY OF SECTION 4(f) ANALYSIS

At the start of this project, two properties in the Alewife Corridor identified as potential significant Section 4(f) properties were the Alewife Brook Reservation and the Thorndike Street Playground. Although it was eventually decided by the MDC that the portion of the Alewife Brook Reservation affected by the project was not significant for purposes of Section 4(f) (referred to as Reservation East in this document), the planning process made every effort to examine alternatives to using either property. Avoiding the Thorndike Street Playground was relatively easy. It proved to be impossible, however, to attain the project's objectives without acquiring or affecting to some extent portions of the Alewife Brook Reservation East. The only alternative to using this portion of the Reservation was the No-Build, which was not considered to be prudent.

The Minimum-Build Alternative has been developed as the most positive "build" solution to the avoidance of Section 4(f) lands. It avoids completely the Thorndike Street Playground. Although the Alewife Brook Reservation East is not considered significant by the MDC for purposes of Section 4(f), the Minimum-Build has been schematically designed to minimize impacts to the Reservation and, with enhancement measures, to improve the accessibility of the Reservation for possible recreational use in the future.

IV SUMMARY

This Environmental Overview Summary Update has described the process and the findings from that process which have led to the MDPW's selction of the Minimum-Build Alternative as the proposed course of action for roadway improvements in the Alewife Corridor of Cambridge, Arlington and Belmont, Massachusetts. The MDPW's selection of the Minimum-Build Alternative for further project development is the result of almost two years of intense environmental and engineering study, during which time the roadway alternatives selection/development/evaluation process has been subjected to close public scrutiny and reaction. While not possessing all the operational and design features which the MDPW and some public groups might have desired, the Minimum-Build Alternative does represent the preferred roadway option of the MDPW in the context of this process. It meets basic project objectives related to improvements in access and roadway safety and is at a scale which is acceptable to a broadbased cross-section of the public--community groups, public officials, and special interests. It is also consistent with state transportation policy regarding the shifting of travel emphasis to public transportation and away from the private automobile, in two ways. First, it provides improved access to the proposed MBTA station/garage at Alewife, a positive inducement to the use of public transportation in the Northwest Corridor. Second, it does not increase through-traffic roadway capacity in the Alewife area, which, therefore, should not encourage increased commutation by the private automobile through the Northwest Corridor.

The Minimum-Build Alternative is not intended to significantly improve traffic service through the Alewife Corridor. In comparison to the No-Build Alternative, only traffic service on Route 2, between Lake Street and Dewey-Almy, will be noticeably improved. This may result in continued increased traffic on some local streets, as through traffic attempts to avoid the traffic congestion on the Alewife Brook Parkway, a characteristic also of the No-Build Alternative. However, the North Cambridge neighborhood in the vicinity of Rindge Avenue will be protected against encroachment by Parkway southbound and Rindge Avenue Extension traffic as a result of the improved Parkway/Rindge Avenue intersection. In addition, by providing a new direct connection from Route 2 to the Rindge Avenue Extension, roadway access to the proposed MBTA Red Line station/garage at Alewife will be improved. Access to Cambridge's "Industrial Triangle" area will also be improved. This direct connection to Route 2 will serve to relieve the Alewife Brook Parkway of some heavy Route 2 traffic from the northwest--automobile, bus, and truck--which would have otherwise utilized the Parkway to gain access to these developments.

The Minimum-Build, besides improving access to major corridor activities, also will result in improved vehicular and pedestrian safety. A 17-per-cent yearly reduction in accidents for that portion of the Alewife traffic network improved by the Minimum-Build Alternative would be realized. This accident reduction is a result of several factors, including elimination of direct access and egress to adjacent development along Route 2 east of Lake Street, replacement of the Dewey-Almy Circle with a signalized, channelized intersection, improvement of sight distances in the vicinity of the Dewey-Almy Circle, replacement of the substandard and deteriorated bridge over the Boston and Maine Railroad's Freight Cutoff, increased lane widths (from 10 feet to 11 feet) on the Parkway between the Dewey-Almy Circle and Rindge Avenue, and realignment and improved channelization and signalization at the Rindge Avenue/Alewife Brook Parkway intersection.

The Minimum-Build Alternative is not anticipated to have an appreciable long-term effect on regional growth patterns, as it does not significantly improve regional highway accessibility. However, as stated previously, it does improve accessibility to the proposed MBTA station/garage and Cambridge's "Industrial Triangle" area, which could affect local growth patterns within and adjacent to these developments.

The Minimum-Build Alternative will minimize encroachment on the Alewife Brook floodplain by utilizing viaduct structures where possible in the vicinity of the MDC's Alewife Brook Reservation near Dewey-Almy Circle. Approximately 1.2 acres of floodplain, or less than 1 per cent of the total Alewife floodplain area, will be utilized by the proposed improvements. Adequate replacement floodwater storage areas will be provided within the MDPW's right-of-way in the vicinity of Route 2 and Dewey-Almy Circle.

The aggregate impacts on vegetation and wildlife within the floodplain, and specifically within the Alewife Brook Reservation East, is anticipated to be slight in comparison to the No-Build condition. No threatened or endangered species exist in this area. Approximately 2.9 acres of the Alewife Brook Reservation East (2.3 per cent of total Reservation acreage) will be used by the Minimum-Build Alternative, much of that area overlapping, or being the same as, the acreage being taken from the floodplain.

The Alewife Brook Reservation was examined as a potential Section 4(f) land. A letter from the MDC was received, stating that the portion of the Reservation which this document refers to as the Reservation East was not significant for purposes of Section 4(f). The Minimum-Build Alternative impacts only the Reservation East; the remainder of the Reservation is not affected by this proposed improvement. The only other potential Section 4(f) site close by, the Thorndike Street Playground, will not be used nor require any permanent landtakings or temporary easements in conjunction with construction of the Minimum-Build Alternative.

Approximately 1.2 acres of vacant open-space land owned by Arthur D. Little, Inc. and others along Route 2 eastbound will also be acquired for the proposed access road from Acorn Park Road to the rear of the commercial establishments along Route 2. A portion of this acreage is also within the floodplain storage area previously identified as being taken.

No historical sites or archeological sites within the area were identified as being in close enough proximity to the construction site for the Minimum-Build such that they would be impacted by the proposed improvement. The Minimum-Build Alternative will not impact any religious, health, and educational facilities in the area. Some public utilities relocations may be required. Fire, police, ambulance, and other emergency services should be improved as a result of improved access to the industrial/commercial portions of the area, the installation of fire and police preemption devices at the signalized intersections, and the widened roadway widths which will better allow vehicles to pull over and permit emergency vehicles to pass. In addition, more direct access to the Arthur D. Little, Inc. complex from Cambridge, long a fire department priority, could be possible from the inbound viaduct of the Route 2-Rindge Avenue Extension connection.

As the residential neighborhoods of Arlington, Belmont and Cambridge are located far enough from the roadway improvements envisioned under the Minimum-Build Alternative, no major impacts on neighborhood character or stability should ensue, except possibly for continued increased traffic movements on some residential streets as some motorists attempt to avoid congestion on Route 2 and the Parkway. However, the improved Rindge Avenue/Rindge Avenue Extension/Parkway intersection will prohibit left turns into Rindge Avenue and the North Cambridge Neighborhood by Parkway southbound traffic and Rindge Avenue Extension traffic.

As the proposed improvements will occur primarily within existing roadway and rail rights-of-way, and on vacant lands, no displacement of residents or businesses will occur as a direct result of this project. However, damages to some of the business enterprises along Route 2 eastbound as a result of elimination of the direct Route 2 access, and possible damages to a drive-in restaurant situated on a corner of the improved Parkway/Rindge Avenue intersection as a result of elimination or relocation of its curb openings, may result in full takings, and subsequent displacements, of these business parcels. The two service stations presently located along Route 2 seem most susceptible to such an occurrence in that area. No residential property acquisition will be required. Business land acquisition will amount to 5.9 acres, 4.7 acres of which is industrial (some vacant) and 1.2 acres of which is commercial. Total costs for land acquisition are estimated to be $1,008,000, with a resulting tax loss to the three communities of $29,000, based on 1974-1975 valuations and tax rates.

The Minimum-Build Alternative will not appreciably alter noise levels in the Alewife Corridor, the net increase over existing

(1975) conditions for the year 2000 traffic amounting to approximately 2 decibels at sensitive noise receptors such as the Rindge Towers apartment complex and the East Arlington residences closest to Route 2. The Minimum-Build Alternative will not appreciably alter air quality, with compliance with strict federal requirements for vehicle emissions benefiting area air quality more than the improvements themselves. Within the limits of the proposed highway improvements, the quantity of paved roadway will increase by approximately 50 per cent over the No-Build condition, with a subsequent increase in runoff. This increase in runoff should be relatively insignificant in comparison to the total runoff from the impervious areas contained within the 5300-acre watershed area of which the Alewife Corridor is a part. The provision of replacement flood storage areas, in addition to reducing flood peaks, should allow time for the natural regeneration of runoff waters which might otherwise impact the quality of waterbodies in the area.

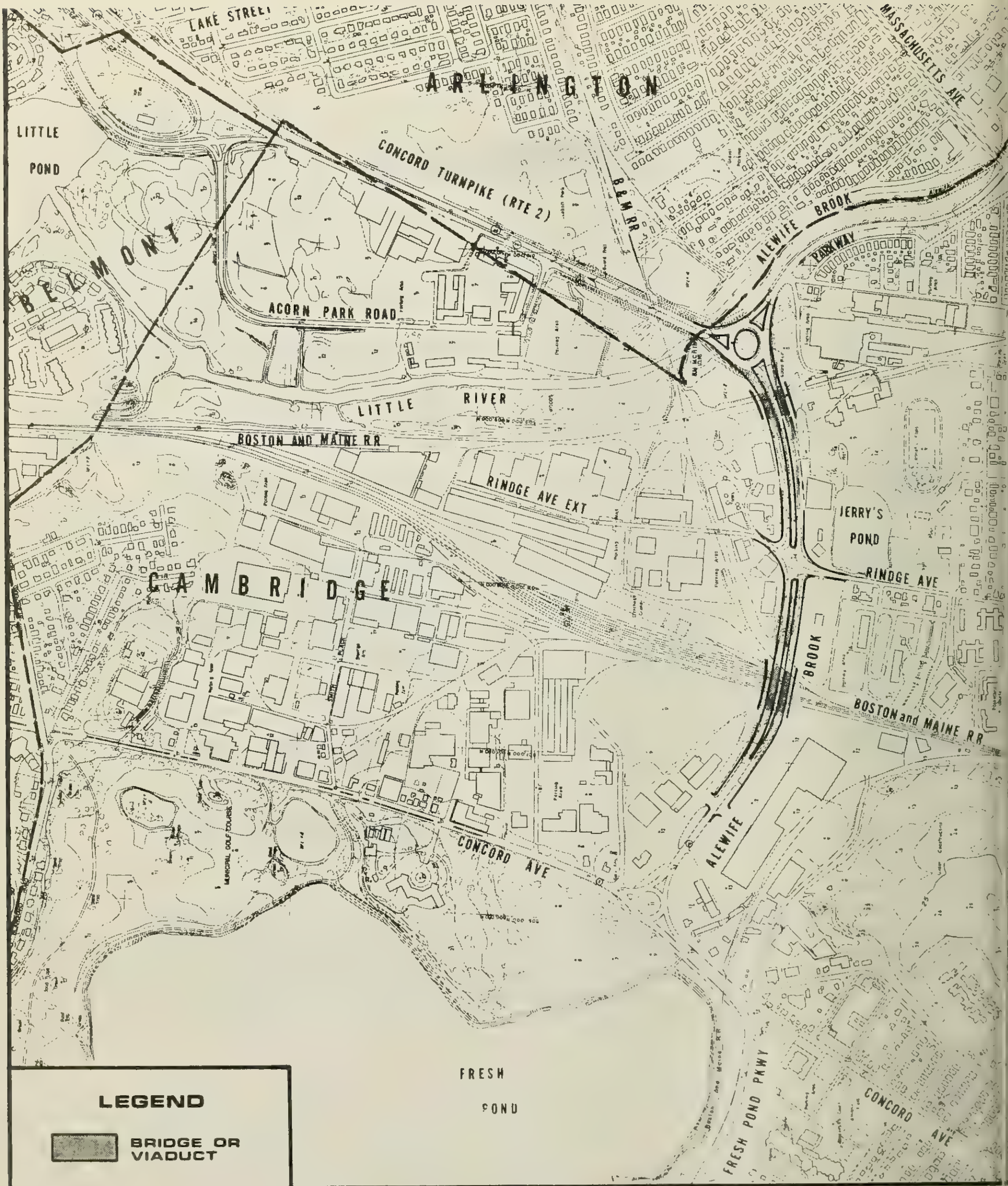
Except for the proposed connection between Route 2 and Rindge Avenue Extension, the visual scale of the improvements which comprise the Minimum-Build Alternative is comparable to the No-Build condition. The proposed connection will increase the amount of roadway improvements in the area, but is still comparable in scale to the improved Parkway cross-section and the MBTA station/garage. Furthermore, much of its visual scale effects will be confined to the "Industrial Triangle" area south of the Freight Cutoff. All roadway improvement structures will be designed to be architecturally pleasing, to be consistent with the area's topographic features, and to avoid massiveness. Landscaping of natural areas, along with the new pavement and structures, should in fact improve the esthetic qualities of the roadways over and above their present "No-Build" appearance.

The estimated project cost for the Minimum-Build Alternative is approximately $13.9 million, including both construction and land-acquisition costs.

Finally, public reaction to this alternative is mixed, as it contains operational and design features supported by some groups and criticized by others. To the MDPW, it represents a viable compromise roadway solution which is acceptable to most public officials and private groups which provided inputs to this study.

APPENDIX

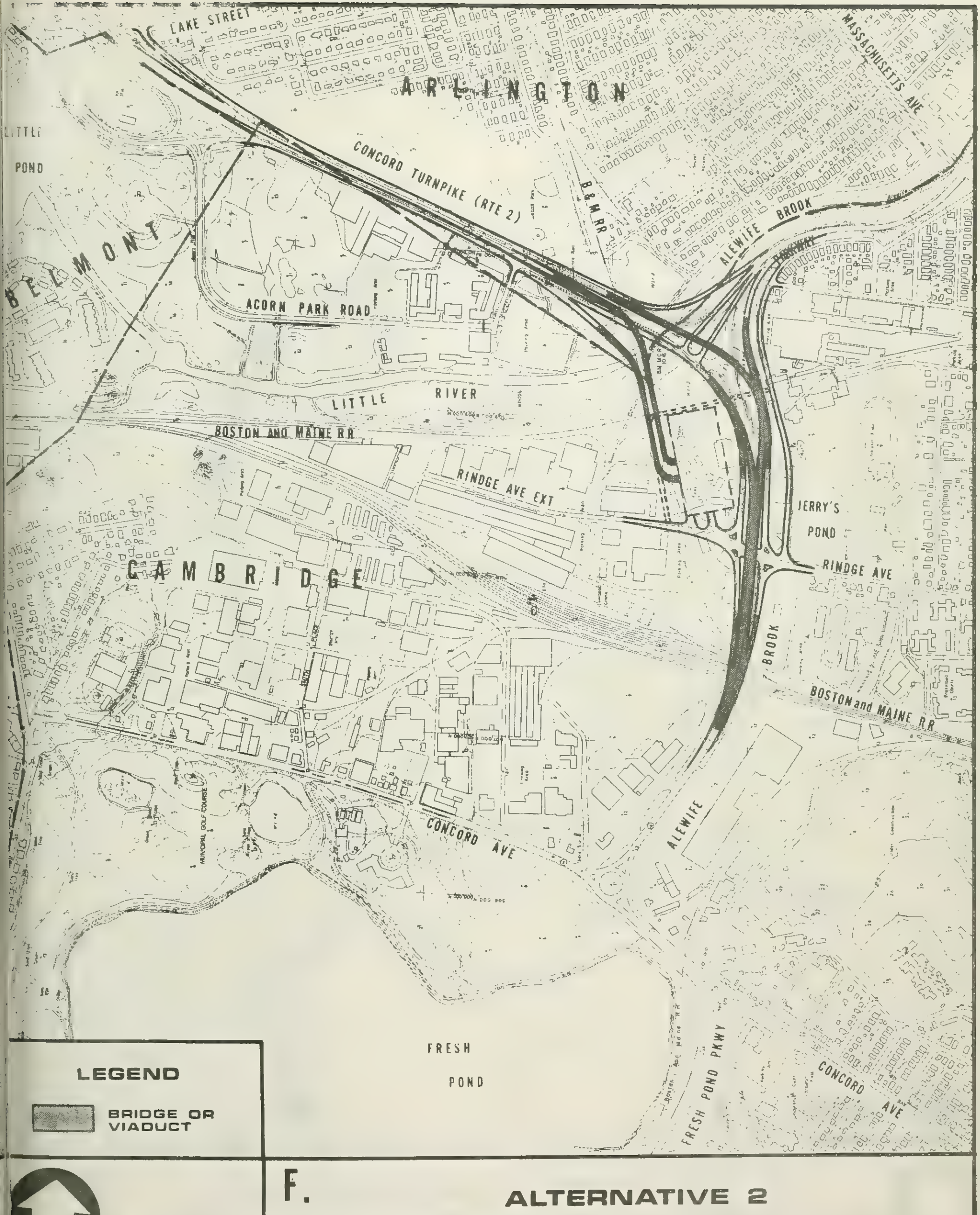
EXHIBITS A TO K:	Post-EOS Alternatives.
EXHIBITS L TO M:	MDPW Section 4(f) Letters to Metropolitan District Commission and Arlington Parks and Recreation Commission.
EXHIBITS N TO O:	Arlington Parks and Recreation Commission and Metropolitan District Commission Section 4(f) Significance Responses.



F. S. & T. INC. 1977

ALTERNATIVE 1
MODIFIED EOS MINIMUM BUILD ALTERNATIVE
(SEPTEMBER 1975)

Exhibit A



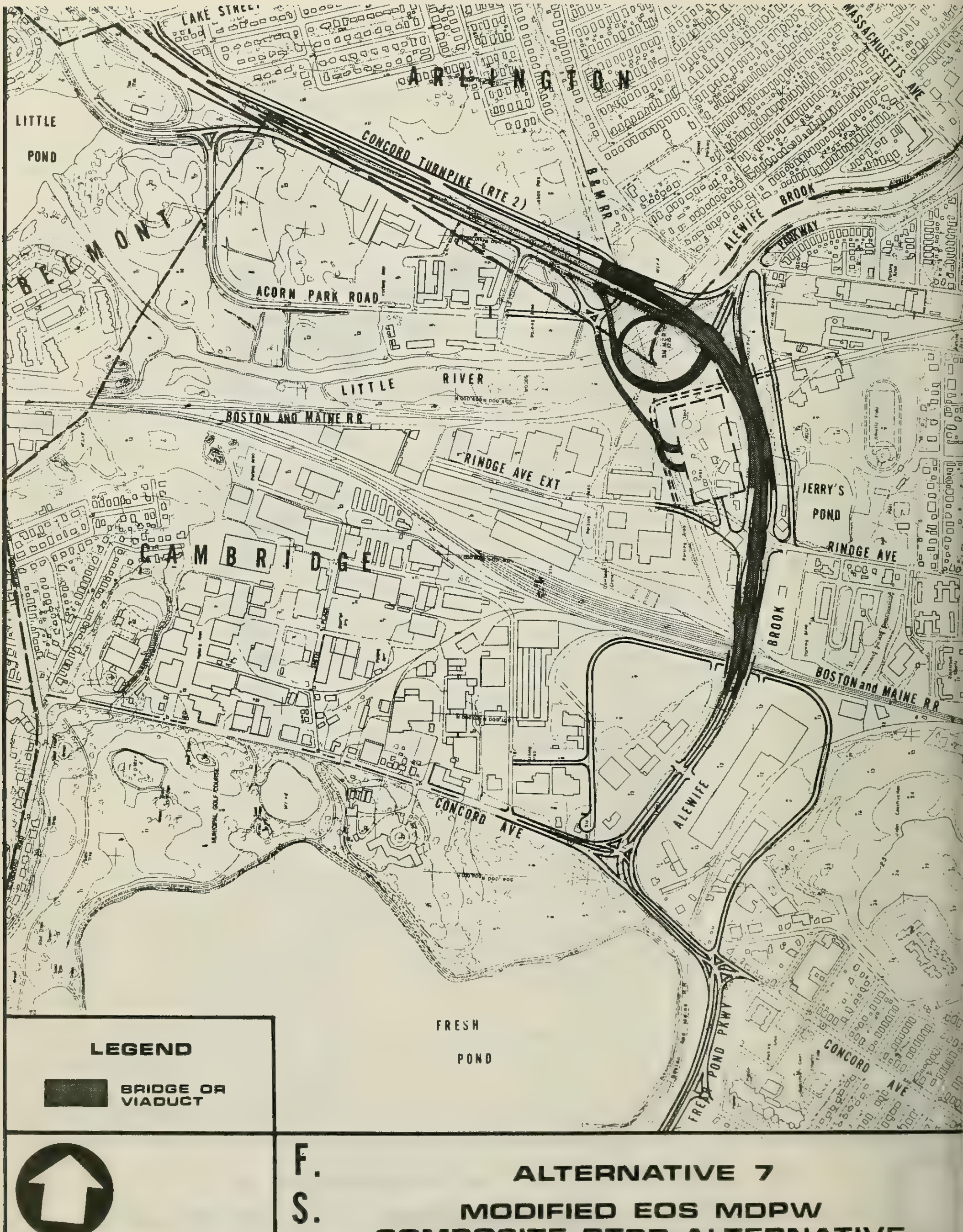
F.
S.
&
T. INC. 1977

ALTERNATIVE 2

MODIFIED EOS LIMITED BUILD ALTERNATIVE

(SEPTEMBER 1975)

Exhibit B



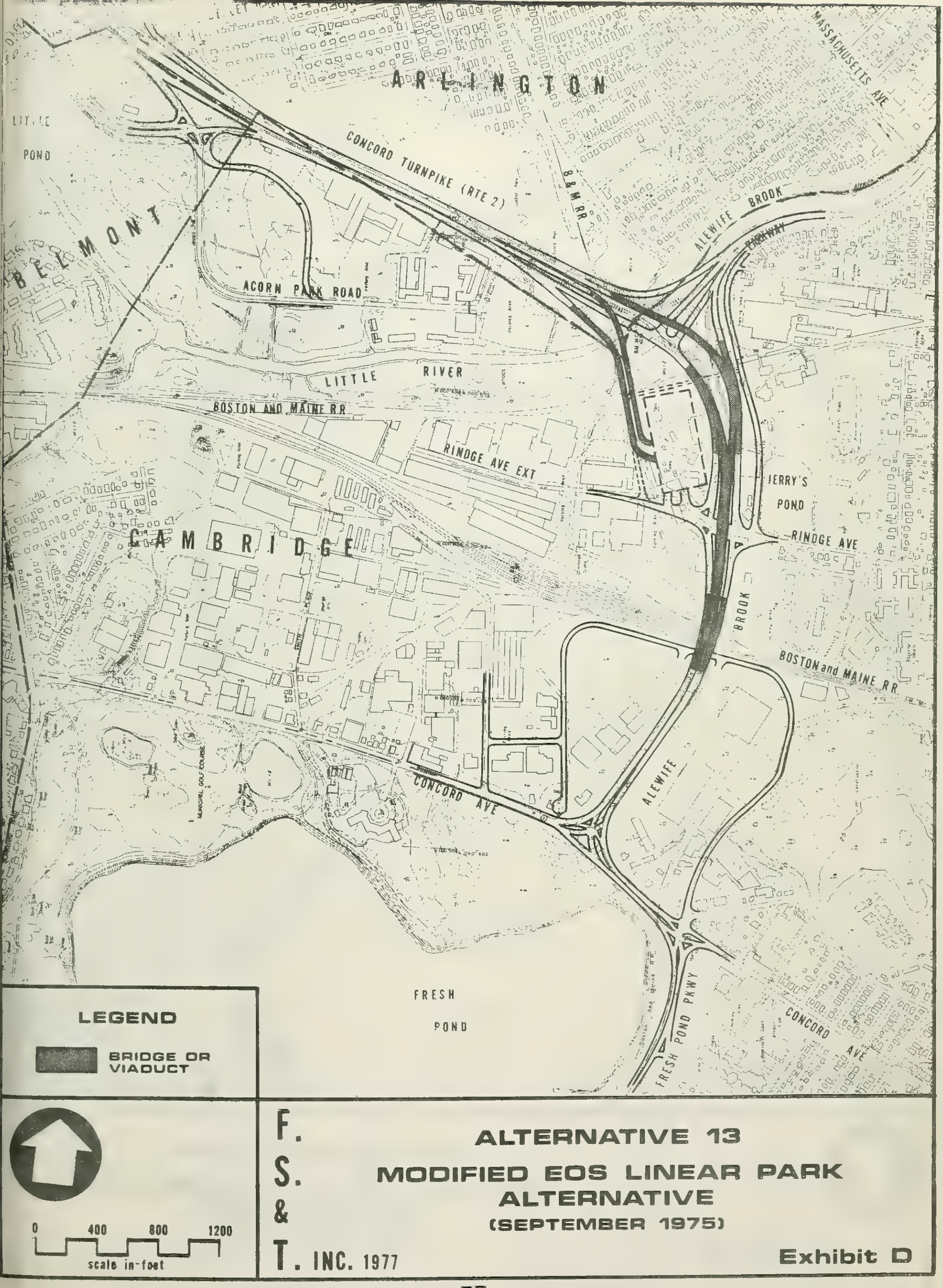
F. S. & T. INC. 1977

ALTERNATIVE 7

MODIFIED EOS MDPW COMPOSITE BTPR ALTERNATIVE

(SEPTEMBER 1975)

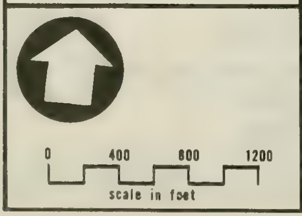
Exhibit C



F. S. & T. INC. 1977

ALTERNATIVE 13
MODIFIED EOS LINEAR PARK ALTERNATIVE
(SEPTEMBER 1975)

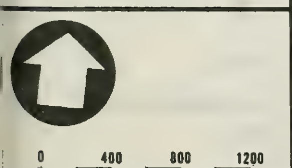
Exhibit D



F.
S.
&
T. INC. 1977

ALTERNATIVE 16
POST EOS STUDY COMPOSITE I ALTERNATIVE
(SEPTEMBER 1975)

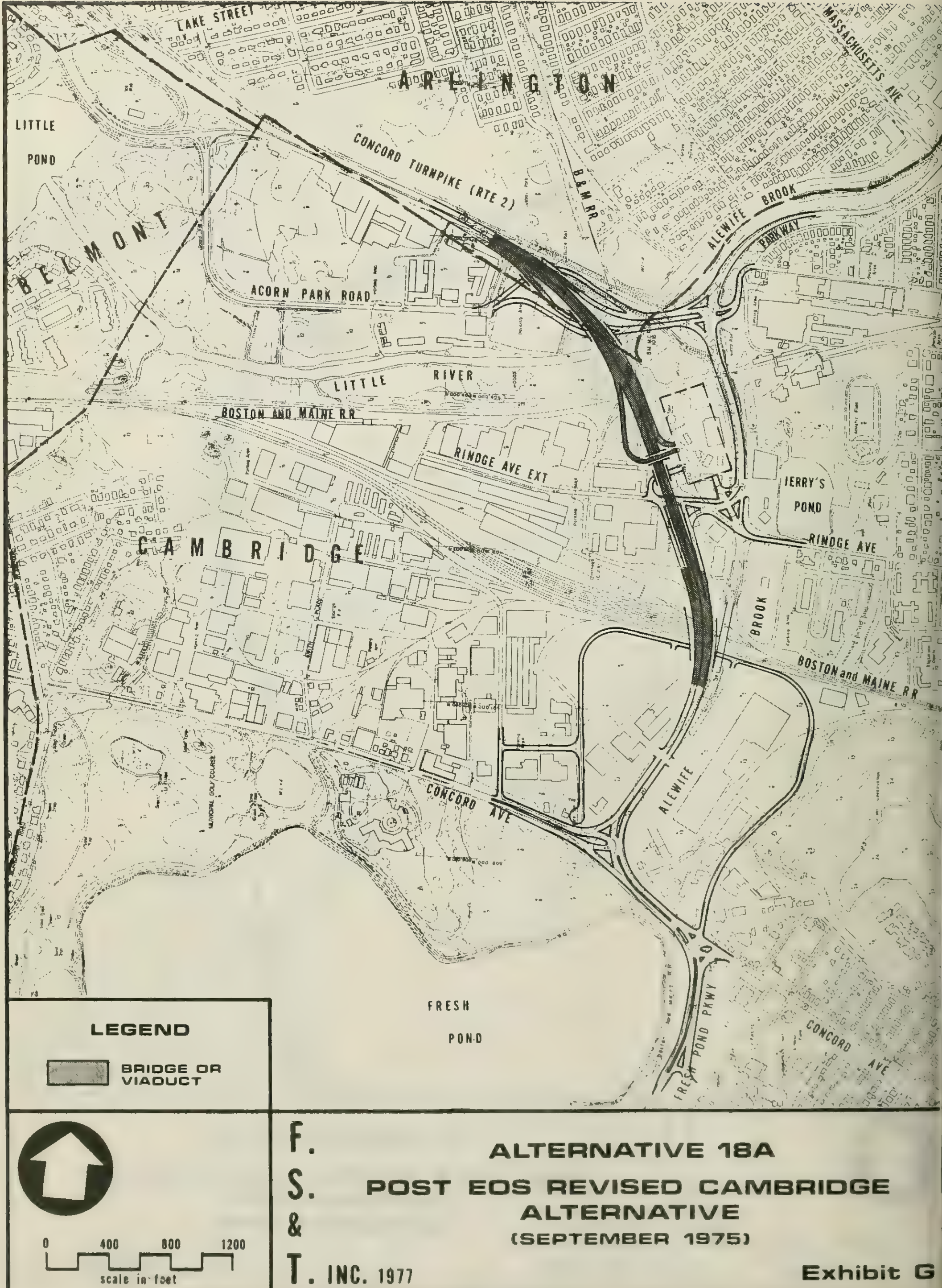
Exhibit E



F. S. & T. INC. 1977

ALTERNATIVE 17
POST EOS STUDY COMPOSITE II ALTERNATIVE
(SEPTEMBER 1975)

Exhibit F



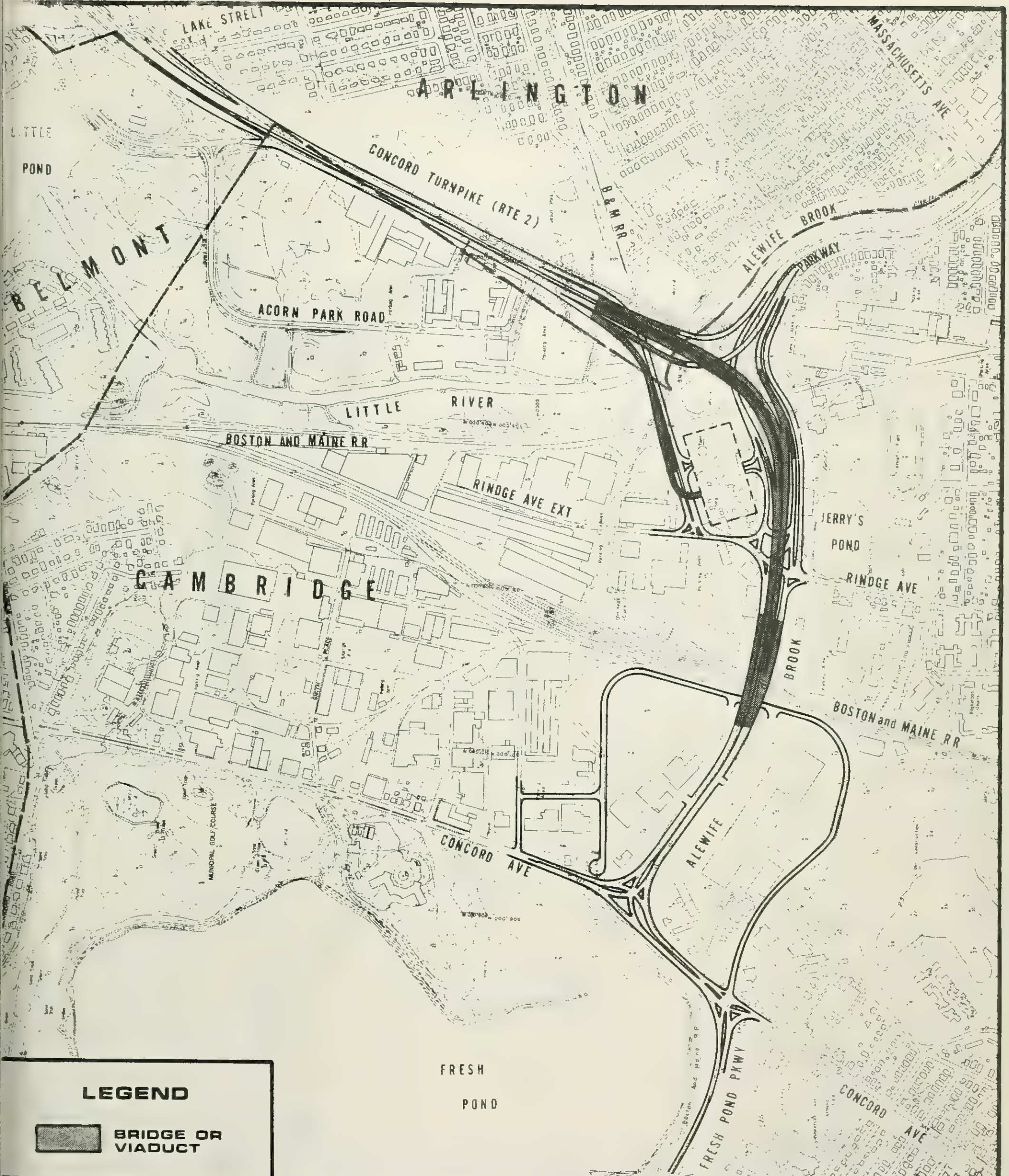
F. S. & T. INC. 1977

ALTERNATIVE 18A

POST EOS REVISED CAMBRIDGE ALTERNATIVE

(SEPTEMBER 1975)

Exhibit G



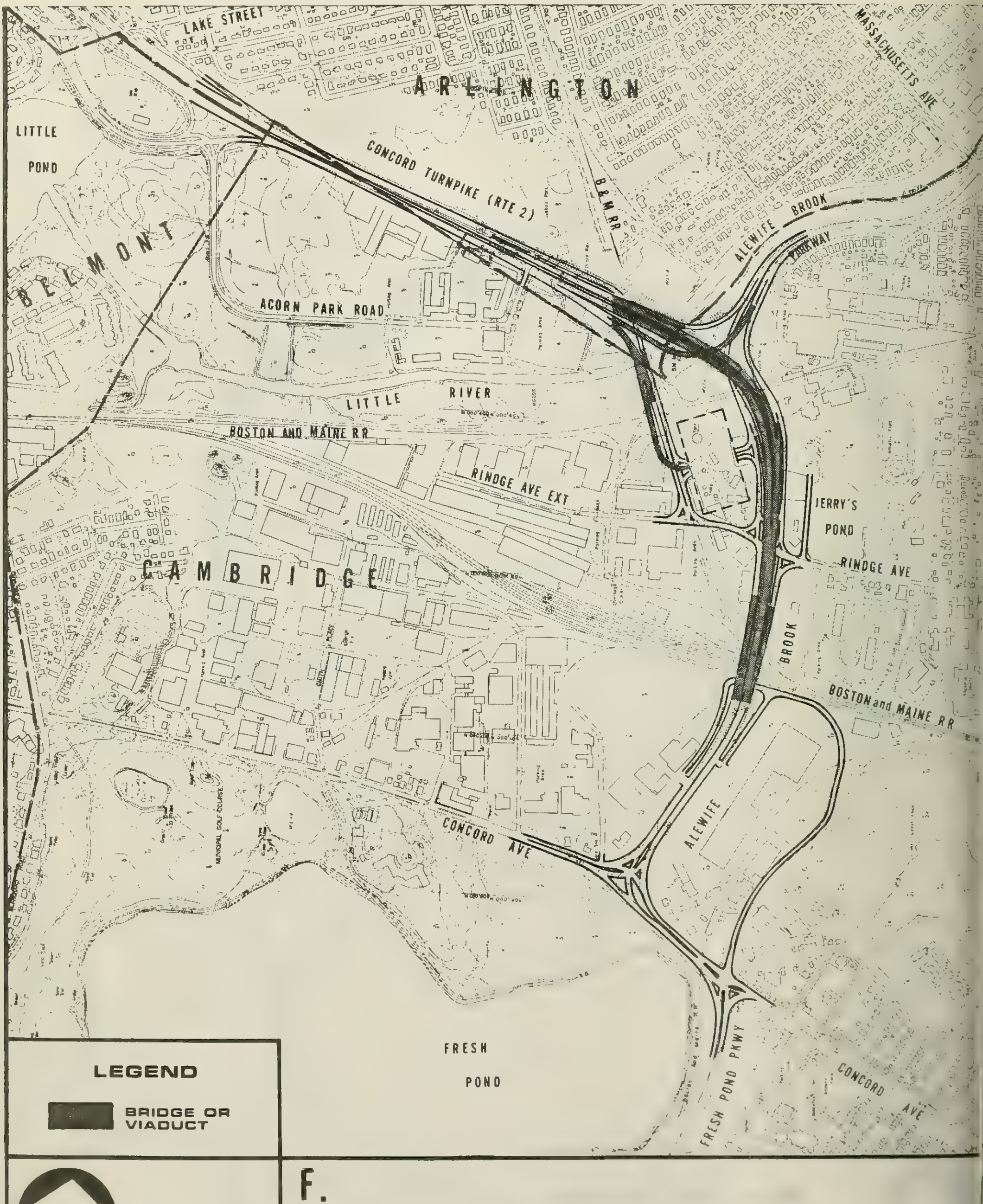
F. S. & T. INC. 1977

ALTERNATIVE 19

POST EOS MODIFIED STAR ALTERNATIVE

(SEPTEMBER 1975)

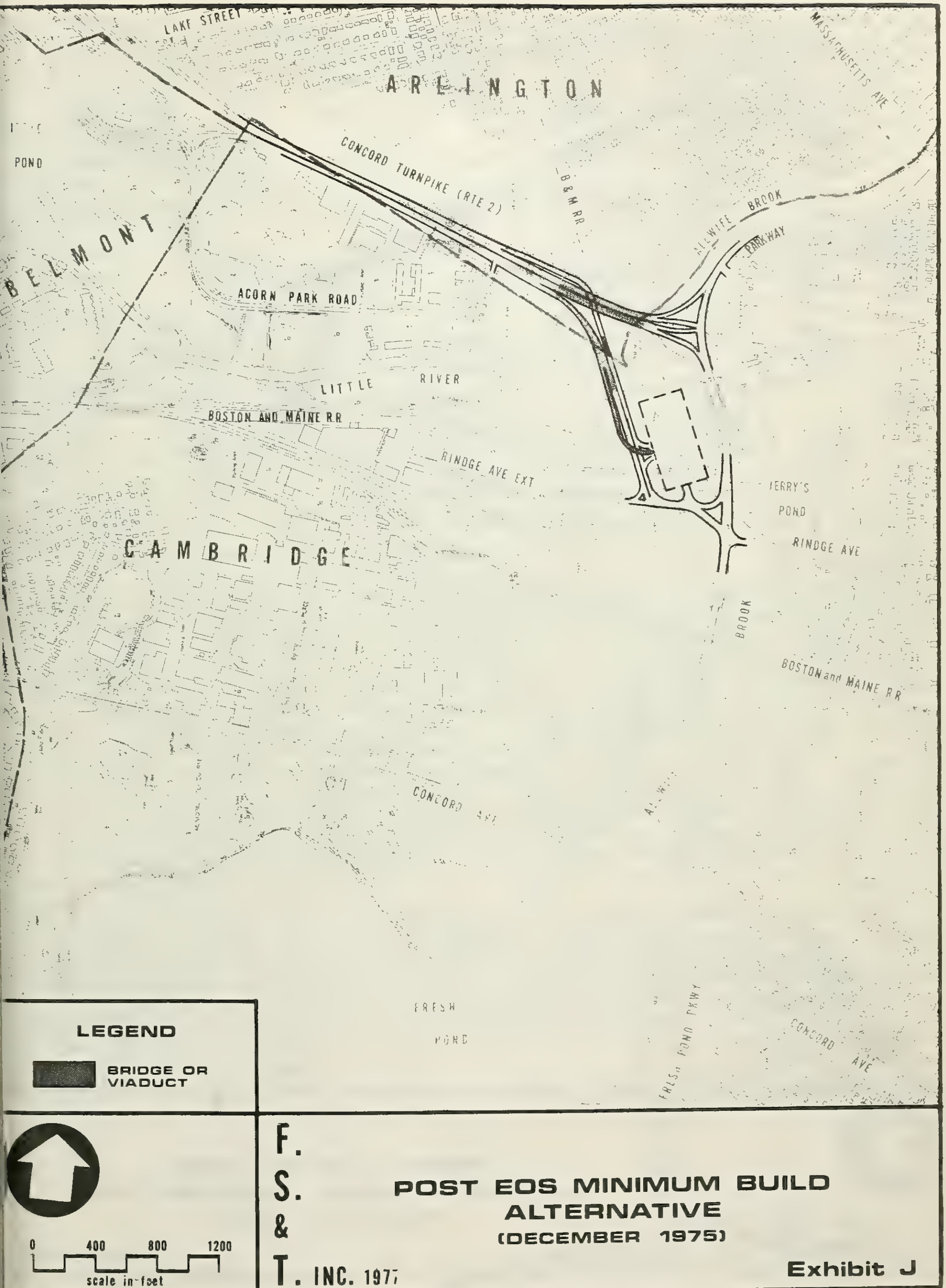
Exhibit H



F. S. & T. INC. 1977

POST EOS REVISED
MODIFIED STAR ALTERNATIVE
(DECEMBER 1975)

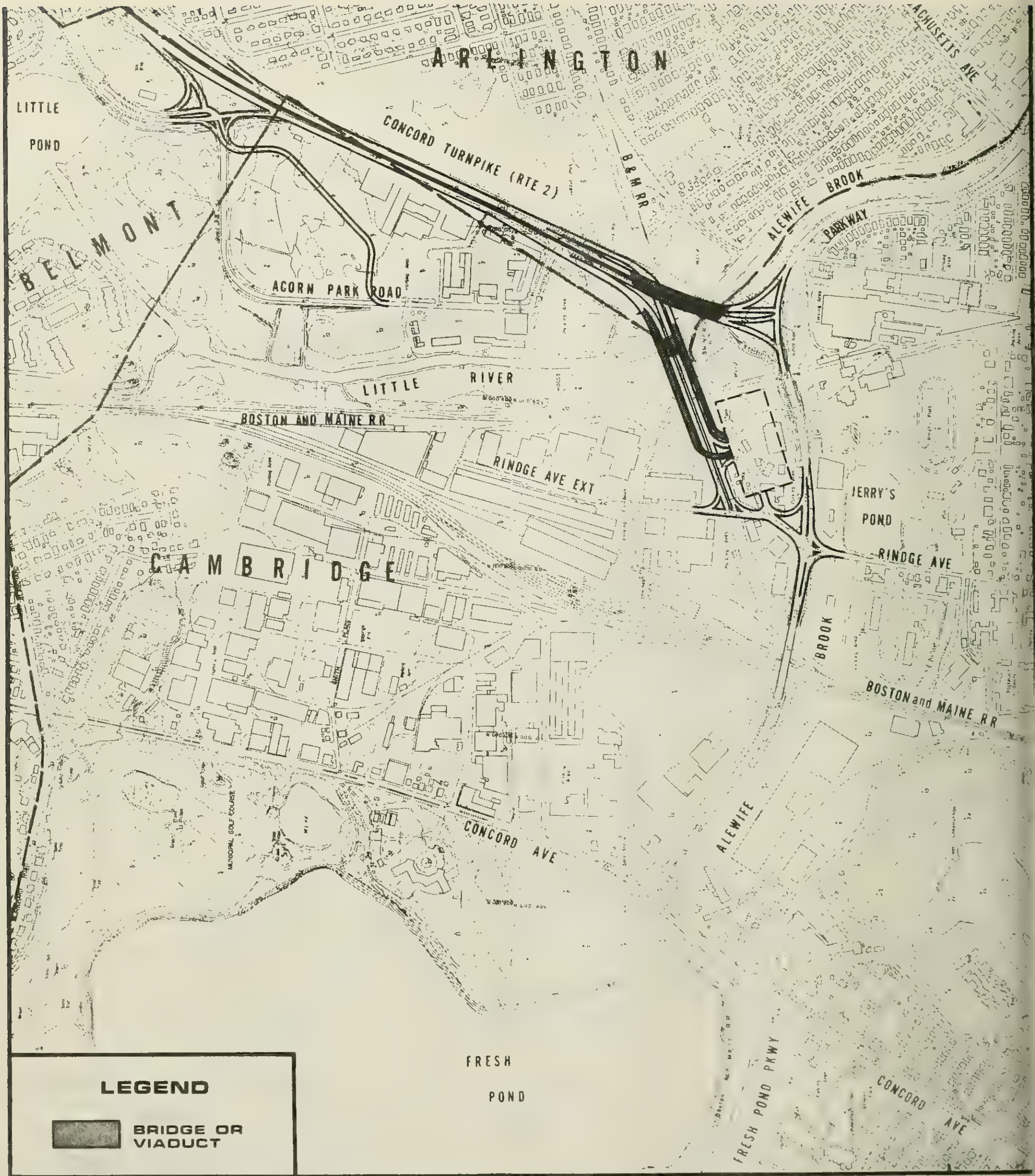
Exhibit I



F.
S.
&
T. INC. 1977

POST EOS MINIMUM BUILD ALTERNATIVE
(DECEMBER 1975)

Exhibit J



0 400 800 1200
scale in feet

F.
S.
&
T. INC. 1977

POST EOS REVISED
MINIMUM BUILD ALTERNATIVE
(NOVEMBER 1976)

Exhibit K

The Commonwealth of Massachusetts

Executive Office of Transportation and Construction

Department of Public Works

100 Nashua Street, Boston 02114

September 17, 1975

Mr. John F. Snedeker, Commissioner
Metropolitan District Commission
20 Somerset Street
Boston, Massachusetts 02108

Subject: Engineering and Environmental Impact Study of Transportation Improvements in the Alewife Area of Cambridge, Arlington and Belmont, Massachusetts

Dear Mr. Snedeker:

The consulting firm of Fay, Spofford & Thorndike, Inc. is presently engaged in the performance of engineering and environmental impact studies related to transportation improvements in the Alewife Area of Cambridge, Arlington, and Belmont, Massachusetts for the Massachusetts Department of Public Works. More specifically, highway improvements which will improve vehicular and pedestrian safety and will improve access to existing and future land uses are being considered for the Concord Turnpike (Route 2), from Lake Street east to Dewey-Almy Circle; for the Alewife Brook Parkway, from a point just north of Dewey-Almy Circle to Concord Avenue to the south; Concord Avenue from the Alewife Brook Parkway to the Fresh Pond Parkway; and the Fresh Pond Parkway, from Concord Avenue south to the approximate vicinity of Lake View Avenue.

Section 4(f) of the United States Department of Transportation Act of 1966, as amended, requires that any transportation project which requires the use of publicly owned land, such as a park, recreation area, or wildlife and waterfowl refuge, be reviewed for its significance from the viewpoint of the officials having jurisdiction over this land.

Exhibit L

To initiate the Section 4(f) review for this study, a determination of the significance of the Alewife Brook Reservation, the MDC skating rink at Lake Street, the Alewife Brook Parkway, and the Fresh Pond Parkway as Section 4(f) lands is required from the Metropolitan District Commission. I, therefore, respectively request a response from the Commission of Section 4(f) significance, which will include the following considerations:

(1) A statement that the Metropolitan District Commission is in fact the official having jurisdiction over the Alewife Brook Reservation, the MDC skating rink at Lake Street, the Alewife Brook Parkway, and the Fresh Pond Parkway in the Alewife Area;

(2) A determination of whether in the Commission's opinion the land and facilities within each of these four areas are significant for the purposes of Section 4(f); and

(3) A statement of the Commission's reasons for its determination of significance.

I am aware that the Commission was contacted during the BTPR Study in 1972 for the same purpose, and wish, nonetheless, to reaffirm the Commission's position relative to these four areas at this time.

The Section 4(f) report will be included as part of the environmental study documents prepared by the consultant which are required by the National Environmental Policy Act.

Enclosed is a list of the subject matter which the consultant must address in preparing the Section 4(f) Statement. The Department and consultant would be pleased to meet with members of your Commission at their convenience to secure any available information which the Commission has in these areas.

Should you have any questions, please do not hesitate to contact Mr. Robert Horigan, an Environmental Engineer of the Department and the Department's Environmental Coordinator for this study, or Dr. Rodney Plourde of Fay, Spofford & Thorndike, Inc., Project Engineer for this study.

Very truly yours,

Robert T. Tierney, P.E.
Chief Engineer

RTT:db
Encl.

SECTION 4(f) STATEMENT CONTENTS
METROPOLITAN DISTRICT COMMISSION

(1) Project and Section 4(f) lands descriptions.

(2) Section 4(f) land sizes (acres or square feet) and locations (property limits, maps, photographs, slides, sketches, etc., as appropriate).

(3) Types (recreation, wildlife and waterfowl refuge, etc.).

(4) Available activities (fishing, swimming, golf, etc.).

(5) Facilities existing and planned (description and location of baseball diamonds, tennis courts, etc.; planned new facilities such as bicycle paths, etc.).

(6) Usage (approximate numbers of users for each activity if such figures are available).

(7) Relationships to other similarly used lands in the vicinity.

(8) Access (both pedestrian and vehicular) and effects thereupon.

(9) Ownership (city, county, state, etc.).

(10) Applicable clauses affecting title, such as covenants, restrictions or conditions, including forfeiture.

(11) Unusual characteristics of the Section 4(f) lands (flooding problems, terrain conditions, or other features that either reduce or enhance the values of portions of the area).

(12) Consistency of location, type of activity, and use of the site with agency and community goals, objectives and land-use planning.

(13) Use of federal or state funds for acquisition or development of site. Other factors relevant to the Commission's determination.

(14) Location and amount of land (acres or square feet) to be used by the highway.

(15) Facilities affected.

(16) Probable increase or decrease in physical effects on the Section 4(f) land users (noise, fumes, etc.).

The Commonwealth of Massachusetts

Executive Office of Transportation and Construction

Department of Public Works

100 Nashua Street, Boston 02114

September 3, 1975

Mr. James Fowler, Chairman
Parks and Recreation Commission
33 Ryder Street
Arlington, Massachusetts 02174

Subject: Engineering and Environmental Impact Study of Transportation Improvements in the Alewife Area of Cambridge, Arlington and Belmont, Massachusetts

Dear Sir:

The consulting firm of Fay, Spofford & Thorndike, Inc. is presently engaged in the performance of engineering and environmental impact studies related to transportation improvements in the Alewife Area of Cambridge, Arlington and Belmont, Massachusetts for the Massachusetts Department of Public Works. More specifically, highway improvements which will improve vehicular and pedestrian safety and will improve access to existing and future land uses are being considered for the Concord Turnpike Route 2), from Lake Street east to Dewey-Almy Circle; for the Alewife Brook Parkway, from a point just north of Dewey-Almy Circle to Concord Avenue to the south; Concord Avenue from the Alewife Brook Parkway to the Fresh Pond Parkway; and the Fresh Pond Parkway, from Concord Avenue south to the approximate vicinity of Lake View Avenue.

Section 4(f) of the United States Department of Transportation Act of 1966, as amended, requires that any transportation project which requires the use of publicly owned land, such as a park, recreation area, or wildlife and waterfowl refuge, be reviewed for its significance from the viewpoint of the officials having jurisdiction over this land.

To initiate the Section 4(f) review for this study, a determination of the significance of the Thorndike Street Playground and Magnolia Street Playground as Section 4(f) lands is required from the Parks and Recreation Commission. I, therefore, respectfully request a response from the Commission on Section 4(f) significance, which will include the following considerations:

Exhibit M

(1) A statement that the Parks and Recreation Commission is in fact the official having jurisdiction over the Thorndike Street Playground and Magnolia Street Playground;

(2) A determination of whether in the Commission's opinion the land and facilities within each of these two recreation areas are significant for the purposes of Section 4(f); and

(3) A statement of the Commission's reasons for its determination of significance.

I am aware that the Commission was contacted during the BTPR Study in 1972 for the same purpose, and wish, nonetheless, to reaffirm the Commission's position relative to these two recreation areas at this time.

The Section 4(f) report will be included as part of the environmental study documents prepared by the consultant which are required by the National Environmental Policy Act.

Enclosed is a list of the subject matter which the consultant must address in preparing the Section 4(f) Statement. the Department and consultant would be pleased to meet with members of your Commission at its convenience to secure any available information which the Commission has in these areas.

Should you have any questions, please do not hesitate to contact Mr. Robert Horigan, an Environmental Engineer of the Department and the Department's Environmental Coordinator for this study, or Dr. Rodney Plourde of Fay, Spofford & Thorndike, Inc., Project Engineer for this study.

Very truly yours,

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS
By

Robert T. Tierney, P.E.
Chief Engineer

RTT/jd
Enclosure

BOARD OF PARK COMMISSIONERS
33 RYDER STREET

WILLIAM F. CANTY
SUPT PARKS AND RECREATION

DANIEL F. BROSNAN, JR.
ASST. SUPT OF RECREATION

ARLINGTON, MASSACHUSETTS 02174
643-6700 EXT. 321-322

PARK COMMISSIONERS:
J. FRED McGANN
LAWRENCE R. BABINE
CHARLES T. KING

November 7, 1972

John G. Woffard, Director
Boston Transportation Planning Review
100 Boylston Street
Boston, Mass. 02116

Dear Mr. Woffard,

In response to your correspondence of October 27, 1972 the following information should be helpful in conducting your restudy.

1. The Board of Park Commissioners do in fact have jurisdiction over the properties listed A through D on your correspondence. These properties are namely; Spy Pond Field, Pond Lane Playground, Scannell Field and Thorndike Playground. Letter E --Whittemore Historic Park is under the jurisdiction of the Board of Selectmen.
2. The critical need for open space in Arlington was so important that the 1972 Town Meeting appointed a special committee to study the problem. To encroach on any of these park lands would indeed be very significant in terms of the amended act of 1966 from the Department of Transportation, section 4 (F). These parks and playgrounds are in constant use during the year, especially from April through December.
3. In response to question three, each area will be taken individually.
   SPY POND FIELD - size 381,726 sq. feet condition - grassy
   facilities located on property - 1 running track (1/8 mile), 3 double tennis courts, 1 single tennis court, 1 maintenance building, 1 bubbler, 1 baseball diamond (backstop), 2 little league diamonds (backstops), 1 shower room/maintenance building, 1 set of permanent bleachers.
   This field is in constant use from April through December for many formal activities not to mention informal play activity by neighbors and Boys' Club members. The Boys' Club is located next to the field between Spy Pond and the field. The Arlington High Junior Varsity Baseball Teams use the field daily for practice and games from May 1 to June 15. The American Legion and the Arlington Baseball Association use the field evenings from May to September. Additionally, during the summer months the Recreation Department uses the field for games and other activities from June 15 to August 15 during the day. In the fall the Arlington High Girls Field Hockey Team, Arlington High Freshman A and B teams use the field for daily practice and games. This does not include the use of the tennis courts which are in constant use from May to mid-November. Also, the field is used for jogging and the hills are used for coasting in the winter months.

Exhibit N

POND LANE PLAYGROUND - size 161,724 sq. feet condition - grassy shady
facilities located on property - t picnic tables, 4 grills
1 merry-go-round, 1 horse swing set, 1 jungle gym, 1 swing
set, 2 slides, 25 benches, 1 baby swing set, 3 horses, 1
parallel bar, 1 storage equipment box.

One of the finest playgrounds in the town and has a constant flow of residents in the summer months, due to the cool air which blows off Spy Pond and the large trees which surround the area. Pond Lane is a supervised playground during the summer months with this summers attendance for 42 days being 4,106 children, an average of over 100 children using the area each day. This area represents the towns only open access to Spy Pond, a tremendous natural resource in the town. Spy Pond has potential for more use and the town is planning to develop the Pond Lane area more fully to get maximum use of the Pond. The 1971 Town Meeting appointed a committee to study Spy Pond and with Pond Lane the only large shoreline owned by the town, this area will be very important in the further development of the Pond. Additionally, the Board of Park Commissioners is in hopes of acquiring adjacent land to Pond Lane and if successful they will apply for funding to develop existing land on the Pond.

SCANNELL FIELD - size 12,637 sq. feet condition - grassy
facilities: 1 little league diamond (backstop) and two dug outs.

Scannell is the best little league field in the town and is used every daylight hour during weekends for games and practices. Each evening from April to mid-July the field is used for little league games. Further, we use the field for recreational baseball games during the summer and the Pond Lane children use it for large muscle activity games during the playground season. The Junior High East School uses the field for physical education classes and after school sports. Additionally, girls softball teams use the field for games and practices as well as the informal play which occurs whenever the field is available.

THORNDIKE PLAYGROUND - size 338,216 sq. feet condition - grassy
facilities: 1 baseball/softball diamond, 1 little league/softball diamond, 1 basketball court, 1 bubbler, 2 swing sets,
4 benches

Thorndike also has a high use factor during the spring, fall and summer months. It is a supervised playground during the summer time from 9:00 AM to 4:30 PM. The Town Softball League uses the field five nights a week for games from May to September. Weekend use during this period is centered around practice sessions for baseball, little league and softball teams as well as informal scrub games. In the fall the high school has the Varsity Soccer Field located at Thorndike.

The field is also used for an Elementary School Flag Football Program. The field is being considered as a project for development along with a tract of land on the other side of the railroad tracks. The town has submitted a proposal to H.U.D. for funding of this project and also is planning to contact the Bureau of Outdoor Recreation for possible funding of this project.

I sincerely hope this information will be sufficient. Further research would take more time and the November 10th deadline is close. We received the letter on November 6, 1972.

Sincerely,
BOARD OF PARK COMMISSIONERS

Charles T. King

CTK/l

Charles T. King, Chairman

The Commonwealth of Massachusetts

Metropolitan District Commission

20 Somerset Street, Boston 02108

April 28, 1977

Mr. Robert T. Tierney
Chief Engineer
Department of Public Works
100 Nashua Street
Boston, Massachusetts 02114

Dear Mr. Tierney:

Your letter of September 17, 1975 raised the possible applicability of Section 4(f) of the U.S. Department of Transportation Act of 1966 to certain properties under the jurisdiction of the Metropolitan District Commission in the area of Alewife Brook. This is in connection with plans by the Department of Public Works and the Massachusetts Bay Transportation Authority to undertake federally assisted transportation improvements.

From the proposed plans developed during the past eighteen months, it is now clear that the specific area under the jurisdiction of the M.D.C. to be used for or impacted by the proposed improvements lies at the intersection of the communities of Arlington, Belmont and Cambridge as shown on the attached plan (Attachment 1). The area generally includes the Dewey and Almy (Route 2) Circle northeasterly along Alewife Brook Parkway southerly to the intersection of Rindge Avenue and the area surrounding Alewife Brook including Yates Pond bounded by Route 2, Alewife Brook Parkway, the Boston and Maine Freight cutoff running east-west on the southerly side of the area, and the property owned by Arthur D. Little, Inc. We understand that the project area for the proposed improvements is larger than the area described, but the area described represents the total area under the control of the Metropolitan District Commission which will be either used or potentially affected by the proposed transportation improvements.

Certification of Jurisdiction

The Metropolitan District Commission hereby certifies that it does exercise jurisdiction over the land in question. This property was acquired by the Metropolitan Parks Commission in 1908, and has been under the jurisdiction of the M.D.C. since 1919. While legislation enacted in 1951 (Chapter 491) limits the ability of the Commission to dispose of a portion of the property, the land remains under the jurisdiction of the Commission (see below).

Finding of 4(f) Category - Public Park

As an addition to the Metropolitan Parks System (which was established in the 1890's), the land in question was viewed as establishing a linkage between the Mystic River Reservation to the north and the Fresh Pond - Charles

Exhibit O

River Reservations to the south. As early as 1897, in the 'Diagram of the Parks and Parkways of the Boston Metropolitan District', contained in the reports of the Metropolitan Park Commission, this area is specifically designated as one needed to complete the park reservation system. The Report of 1898 discusses the need for a park acquisition in the Alewife area, and relates this proposed acquisition to the reservation system as a whole. In 1904 the legislature directed that a study be prepared, providing a method to purify Alewife Brook and the surrounding lands, and further directing that the recommendations of this study be made "with due regard...to the plans of the metropolitan park commission for park developments within the said region...". This integration of park development and sanitary improvements reflected an established Park Commission philosophy first outlined in the Report of 1893, in the section on "Sanitary Improvements promoted by Recreative Treatment..." (p. 18-19). In the Report of the Metropolitan Park Commission of 1909 (the year after the Commission acquired the land) the 'Diagram of the Public Open Spaces of the Boston Metropolitan District' places the Alewife lands in the same category as the Blue Hills, the Middlesex Fells, and other major reservations of the Park Commission.

The Metropolitan District Commission was created in 1919 to combine the Park Commission, the Metropolitan Water Board and Metropolitan Sewerage Board and succeeded to the interests of the Metropolitan Park Commission. The Metropolitan District Commission now controls 15,000 acres of parkland in metropolitan Boston. Thus the land to be affected has been under the jurisdiction of a public park agency for seventy years. More recently, this land was included in a list of 36 parks and reservations formally designated as such by vote of the Metropolitan District Commission at its meeting of December 18, 1974. There can therefore be no question that the land to be impacted is a "public park" within the meaning of Section 4(f).

<u>Finding as to "Significance"</u>

Despite the long history of the land in question as public parkland, the land has been dominated by ever increasing transportation uses since its acquisition. The five major transportation uses in the immediate area are as follows:

1. Route 2 and the "Dewey and Almy Circle" bisect the Parkway and the land in question in an east-west direction. Route 2 is the major state highway from the northwestern suburbs to Boston. It is a limited access four-lane highway at this point and carried an average daily traffic (ADT) volume of 44,500 in 1975. Alewife Brook must pass under the highway through a culvert which has for years effectively severed the continuity of the brook and adjacent land.

2. The Boston and Maine Railroad Lexington Branch is a 66-foot right-of-way which bisects the land in question on a north-south alignment. The roadbed stands substantially above the natural contour of the parkland below and breaks the continuity of the land area on the opposite axis from the highway (c.f. above). The right-of-way existed prior to the time the park was acquired by the Metropolitan Park Commission and has been one of the continuing impediments to any park development of the area.

3. The Boston and Maine Railroad Freight cutoff runs on an east-west alignment and provides most of the southern boundary for the area in question except at the easterly end where it bisects the parkway segment and necessitates a high level

bridge over the railroad which has a substantial negative impact on the contour of Alewife Brook Parkway.

4. A paved parking lot comprising approximately 4.5 acres under lease to an abutting business (Arthur D. Little Co.) occupies the entire west end of the land in question. The land was natural low land and was filled and paved in the early 1960's when the lease originated. The lot is used to park approximately 350 cars on a daily basis.

5. Alewife Brook Parkway itself is a major transportation link which in 1975 had an average daily traffic (ADT) volume of 48,900 in this area. Because of its location between Massachusetts Avenue at the Arlington-Cambridge line and Concord and Huron Avenues in Cambridge, connecting to Route 2 West in the mid-section, this section of Alewife Brook Parkway is heavily used by commercial traffic, and is not restricted, like most parkways, to pleasure-vehicles-only. This section of the parkway is dominated by the Route 2 circle and numerous commercial and industrial abutters, including chemical production, metal products, an automobile dealer, gas stations and a fast-food drive-in.

Section 4(f) of the U.S. Department of Transportation Act of 1966 as it appears in Title 23, USC provides:

> "It is hereby declared to be the national policy that special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites. The Secretary of Transportation shall cooperate and consult with the Secretaries of the Interior, Housing and Urban Development, and Agriculture, and with the States, in developing transportation plans and programs that include measures to maintain or enhance the natural beauty of the lands traversed. After the effective date of the Federal-Aid Highway Act of 1968, the Secretary shall not approve any program or project which requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, State, or local significance as determined by the Federal, State, or local officials having jurisdiction thereof, or any land from an historic site of national, State, or local significance as so determined by such officials unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such park, recreational area, wildlife and waterfowl refuge, or historic site resulting from such use."

The Commission understands that the prohibitions and procedures set forth in Section 4(f) do not prohibit the use of all public parkland, but only that of "national, state or local significance...". Although the ultimate determination of "significance" may be made elsewhere, Section 4(f) clearly provides that the threshold determination of "significance" is to be made by the agency having jurisdiction of the land in question. This places on the agency having jurisdiction the responsibility to distinguish between those public parks which are "significant" and those which are not, so as to carry out the spirit as well as the letter of the federal policy of parkland protection.

In considering the question of "significance", the Commission reviewed the data and the descriptions outlined above, and concluded that this area was already a major regional transportation node, and that the significance of the parkland in question has been seriously undermined by the domination of these transportation uses. The significance of this land has been further compromised by state legislation (Chapter 491 of the Acts of 1951) enacted fifteen years in advance of the adoption of Section 4(f). Chapter 491 authorizes and directs the transfer of a major portion of the park land in question to the, then, Metropolitan Transit Authority upon passage of further legislation, but forbids any alternative disposition of the area in the intervening period. This legislation distinguishes the land in question from any other park land in the metropolitan park system in that it is the only pre-4(f) legislation which expresses the intent to transfer a parcel of park land to another use in the future.

For all the reasons set forth above, the Commission by vote at its regularly scheduled meeting of April 7, 1977 made the determination that the land in question, while it is park land, is not "significant" within the meaning of Section 4(f) of the U. D. Department of Transportation Act of 1966.

Hydrology

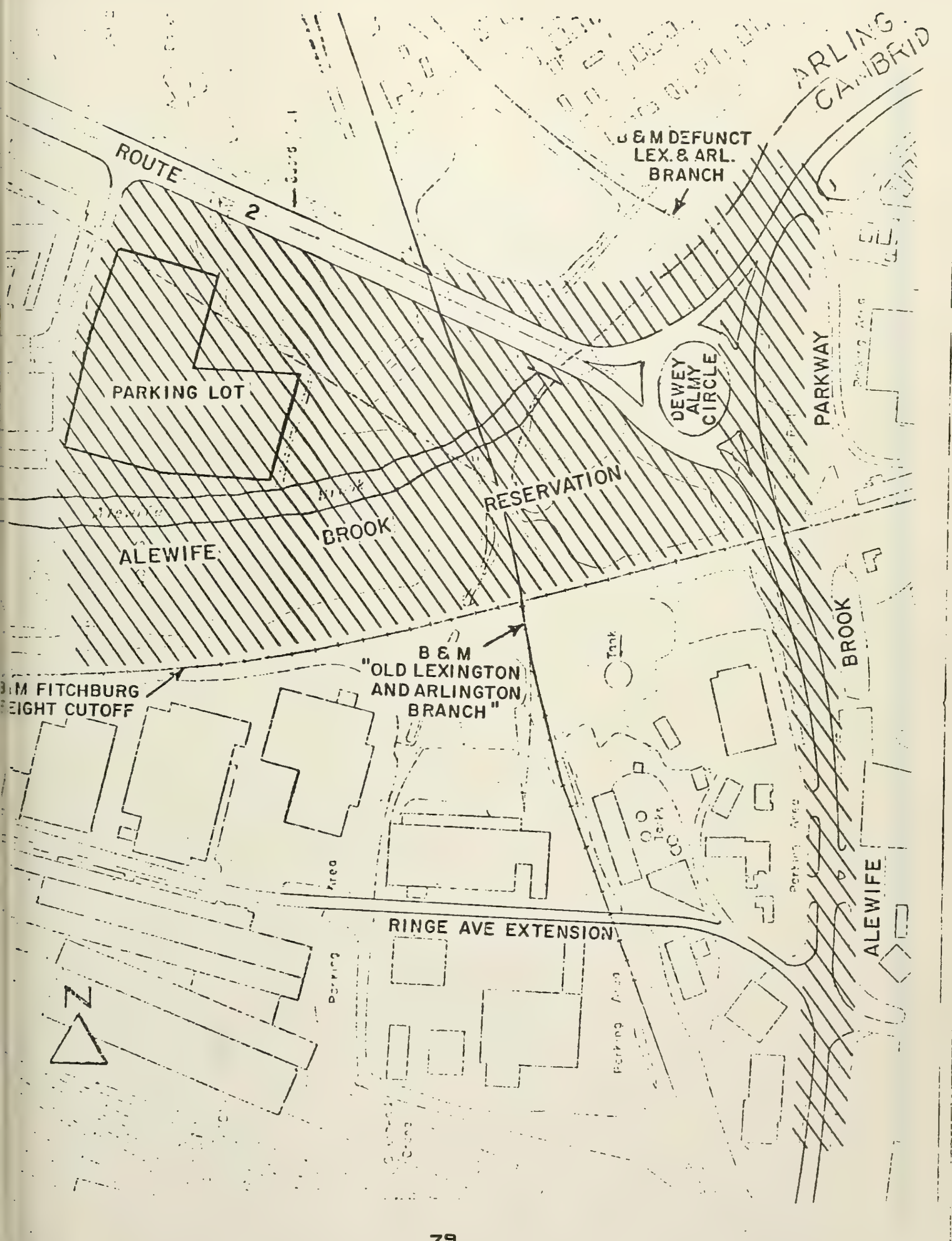
During its consideration of this question, the Commission gave serious attention to the opinions expressed by environmental groups and many members of the public. Concern was repeatedly voiced for the hydrological problems of the Alewife area, and for those parts of the reservation in particular which are wetlands or flood storage areas. Although these issues are definitely outside the formal limits of Section 4(f), the Commission agrees that they are of great importance. We have, therefore, undertaken a hydrology study of the entire Mystic River Watershed of which Alewife Brook is a part, and believe that this study will guide any hydrological alterations in this area. In the design of the transportation improvements intended for this area, the agencies involved have striven to minimize impacts on the wetlands, and to maintain the flood storage capacity of the area.

I hope that this responds adequately to your inquiry concerning the 4(f) status of M.D.C. land in this area. If the Commission can provide any additional information, please do not hesitate to call on us.

Sincerely yours,

John F. Snedeker

JOHN F. SNEDEKER
Commissioner


ROUTE 2
ARLING
CAMBRID
B & M DEFUNCT
LEX. & ARL.
BRANCH
PARKING LOT
DEWEY
ALMY
CIRCLE
PARKWAY
RESERVATION
BROOK
ALEWIFE
B & M
"OLD LEXINGTON
AND ARLINGTON
BRANCH"
B&M FITCHBURG
FEIGHT CUTOFF
RINGE AVE EXTENSION
BROOK
ALEWIFE
N

APPENDIX K

ALEWIFE TRAFFIC STUDY, CITY OF CAMBRIDGE

TRAFFIC ANALYSIS - ALEWIFE/NORTH CAMBRIDGE AREA

A Report on the Traffic and Circulation Impacts of Proposed Transportation Improvements and Potential New Development

prepared for

the

City of Cambridge

by

Norman A. Abend

Traffic and Transportation Consultant
304 Concord Road, Wayland, MA 01778

May 25, 1977

TABLE OF CONTENTS

LIST OF EXHIBITS

SUMMARY

Introduction

This report covers a number of traffic planning activities now taking place in the Alewife area of Cambridge. There are essentially three distinct foci of concentration: 1) the Alewife transit station and garage; 2) the reconstruction of the Dewey/Almy Circle and other roadway changes; and 3) the traffic impacts of potential new development. The Red Line extension has precipitated the broad range of planning now underway, but traffic improvements in the area and some guidance on new development are needed independent of whatever else happens.

Existing Conditions

Route 2 and the MDC parkways constitute a major traffic corridor through the area. Existing traffic volumes on these roadways range between 40,000 and 50,000 vehicles per day. Another group of streets including Blanchard Road, Lake Street, Rindge Avenue and Concord Avenue eastbound all have traffic volumes ranging from 8,000 to 13,000 vehicles per day. Each of these streets serve an identifiable residential area and because of their strategic locations, are used during peak hours by commuting motorists trying to avoid the heavy congestion on the major highways. Concord Avenue west, a major arterial, falls somewhere between these two groups of roadways in regards to function and traffic volumes.

Lake Street, Blanchard Road and Rindge Avenue have one thing in common: because of a combination of natural and man-made barriers, they represent the only continuous passageway for traffic through their service areas, with a resulting concentration of traffic on these streets. However, these streets do have capacity restrictions which limit the level of peak hour traffic volumes. Average traffic speeds throughout the Alewife area on the major highway system range between 10 and 20 miles per hour.

The Alewife station and garage as well as potential new development in the Triangle, Grace and other areas will generate new traffic in the Alewife

area. This additional traffic can be handled in the following ways: 1) construction of new traffic lanes to handle the additional load; 2) modification of intersections to increase capacity without increasing the total number of lanes; 3) locating development to capitalize upon unused traffic capacity; or 4) forcibly displacing through traffic via a combination of discriminatory traffic control measures and allowing the level of congestion to increase.

Major Traffic Proposals

A. The Alewife Station/Garage

The subway station on a daily basis is expected to attract about 3,000 cars. This represents less than five percent (4.8%) of the total approach volume to the Alewife Area right now. Whether this traffic is all diverted from existing approach flows or whether it represents an increase in traffic volumes is not significant. If past experience is representative, any reduction in traffic volumes induced by the Red Line extension would probably be cancelled quickly by increases in other traffic under today's conditions.

Most of the "T" generated traffic is expected to approach the Alewife area from Route 2, with a lesser increment coming from the north via Alewife Brook Parkway. Only a small amount of generated traffic will approach the station from Rindge Avenue or Alewife Brook Parkway south. To handle the volume of traffic from Route 2, a new set of ramps will be constructed. This connection will also provide additional access to the Triangle area, now served by a dead-end roadway connected to the most heavily travelled section of Alewife Brook Parkway.

B. Route 2 - Parkways Reconstruction

This work, to be undertaken by the Massachusetts Department of Public Works and the Metropolitan District Commission, will encompass reconstruction of Route 2 and the Dewey Almy Circle, ramps to the Alewife station, and rebuilding of both railroad bridges. This construction is

intended to satisfy the requirements of the "T", addresses several acknowledged safety hazards, and undertakes some required bridge reconstruction. The work involving the construction between Route 2 and Rindge Avenue has been referred to as the "minimum build" project.

These traffic changes will increase the capacity of Route 2 west of the Alewife station, and are likely to increase intersection capacities by more efficient designs that will not necessarily increase the number of travel lanes through the area. At the Rindge Avenue intersection, the design is expected to satisfy Cambridge City Council intentions of preventing any increased traffic volumes through residential areas. Most traffic entering the Alewife area must pass through a limited number of traffic controlled intersections; thus, these roadway improvements will not increase corridor traffic volumes unless they are accompanied by an increase in capacity at the gateways to Alewife area.

C. Local Development

New development in the Alewife area, with or without the Red Line extension, is expected to have the most impact on traffic in the area. A Red Line Corridor market analysis has concluded that there is a real potential for new development in the Alewife area with or without the Red Line extension. A subsequent Alewife Urban Design Study is now underway (Phase I complete); one purpose of which is to identify the issues and impacts of alternative development possibilities.

Another objective of the urban design effort is to identify land uses that might benefit most from the transit extension, since such uses will have less impact on vehicular traffic generation. New development, even with a high degree of transit orientation, will draw new traffic into the area. Under the most intense development options, the total square footage of development could double, producing a comparable doubling of locally generated traffic.

In real numbers, even modest new development in the Triangle area could

produce 7,000 to 10,000 total trips per day, which is more than the traffic to the subway station. New development in the 26 acres of Grace property could easily produce an equal volume of traffic. These additional loads must be accounted for since they cannot be added to the existing roadway system. In fact, the restrictions in roadway capacity may be partially responsible for the low density development that now exists in the area.

Impacts

Since all of these impending changes to the Alewife area are interrelated, the impacts should be considered in totality. The "T" represents a relatively minor impact in the Alewife area, provided the ramps from Route 2 are constructed. These ramps, with the additional Route 2 capacity to the west, are expected to handle about two-thirds of the traffic generated by the station. Impact on the neighborhood arterials will vary. Blanchard Road is unrelated to any Alewife station approaches and should not be impacted at all. Lake Street in Belmont will probably attract some local traffic that is driving to the Alewife station. However, with stations in Arlington Center and Arlington Heights, there is a practical limit to the numbers of vehicles that would use Lake Street to reach the Alewife station. Peak hour volumes on Lake Street are also limited by the capacity of the railroad grade crossing and the Mass. Ave. intersection.

Some additional traffic can be expected from Belmont on Concord Avenue. Traffic volumes are limited by the signal at Blanchard Road and by the congestion in Belmont Center which acts as an effective barrier to more traffic through Belmont. The Alewife station is expected to draw only a few trips from the south and east because most of the travel in the area will continue to be oriented toward Boston. Very little station generated traffic is expected along Rindge Avenue since much of the North Cambridge neighborhood east of the Alewife station is served by the David Square and Porter Square stations.

Individual development areas could have impacts on adjacent neighborhoods.

The Grace area, for example, if developed with access on Whittemore, will increase traffic volumes in North Cambridge. Efforts are being made to close the Whittemore access and to provide access to the Grace property directly from major highways. Triangle development could have an impact on Rindge Avenue because it is a direct route of approach from Somerville and Central Cambridge. However, the design of the Rindge Avenue - Alewife Brook Parkway intersection should alleviate the problem. Ramps from Route 2 and a connection to Concord Avenue could allow development in the Triangle to occur with greatest orientation toward the west of the transit station. In Arlington, development of the Mugar site without access to Route 2 will have an impact on the entire East Arlington neighborhood that must be addressed.

TRAFFIC REPORT - ALEWIFE/NORTH CAMBRIDGE AREA

Introduction

This report provides a summary of the traffic activities in the Alewife/ North Cambridge area and assesses the traffic impacts of the Alewife station and garage and potential new development on the Alewife area. Transit impacts will occur only if the Red Line is extended; however, development impacts may occur without any transit improvements. The recent market analysis of the Red Line Corridor indicates that substantial development could happen even without construction of the Red Line extension.

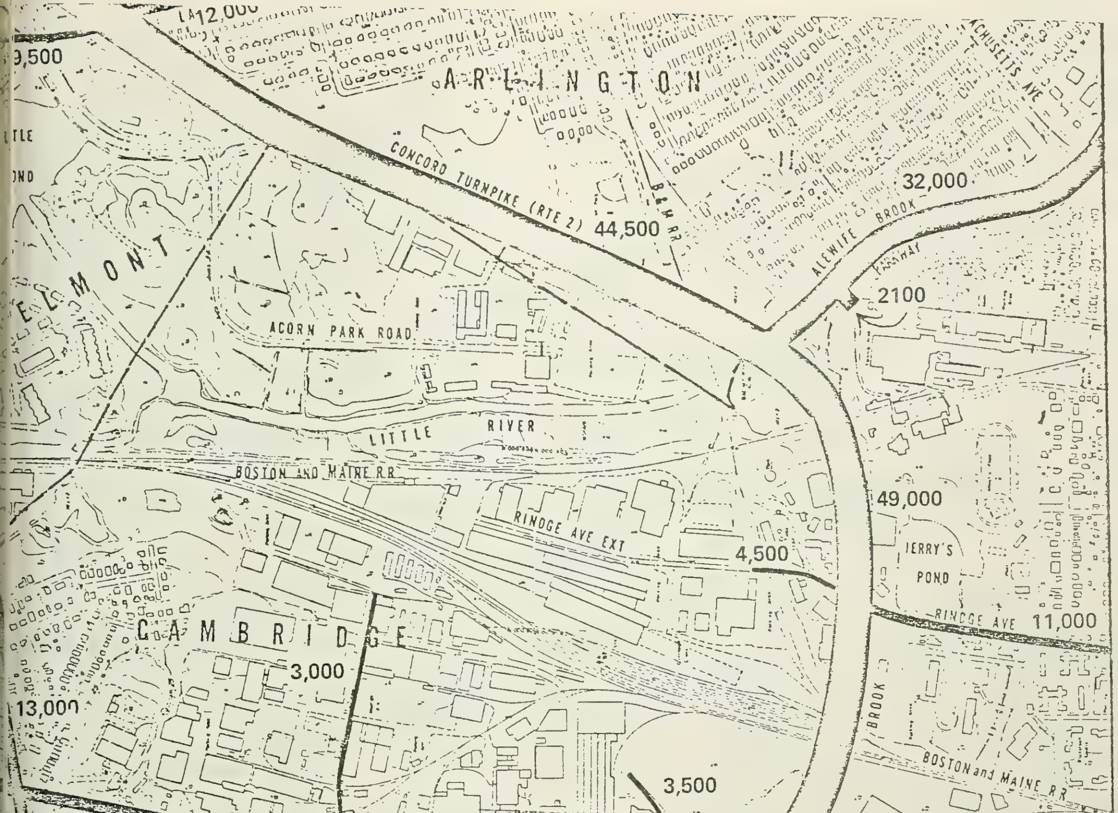
The major purpose of the traffic work is to consider acceptable solutions to the traffic problems which already exist in the Alewife area and to ascertain whether these problems would be exacerbated by the "T" or new development. Because numerous public agencies are involved in planning, designing and implementing new transportation facilities in the area, part of the emphasis in this study has been to look at the overall picture of traffic in the area as it is affected by the several transportation and land development proposals that have been put forth. For a more in-depth analysis of existing commuter characteristics and detailed recommendations for design improvements refer to two companion documents entitled: Alewife Area Employee Survey and Recommendations for Traffic Improvements in the Alewife/North Cambridge Area of Cambridge.

Existing Traffic Volumes

Exhibit 1 shows existing traffic volumes on major streets in the Alewife area. The most significant aspect of this exhibit is the sharp contrast between the major road system through the area and local streets. There are three identifiable levels of traffic volumes on the map. The major roadways have volumes between 30,000 and 50,000 ADT. Important connectors, which travel through residential areas, are within the 10,000 to 15,000 range. Local streets are generally below 5,000 vehicles per day.

In view of the delays involved in travelling through the Route 2 - Alewife Brook Parkway Corridor (see Exhibit 2), it would appear that the traffic volumes shown represent existing capacity. Unless some major alterations are made in the network, future planning for the Alewife area should be based on this framework of existing traffic volumes.

Exhibit 3 shows how traffic volumes have grown in the Alewife area in the past. It is clear that traffic volumes grew dramatically during the '50s and '60s; however, over the past four or five years, there has been stability in traffic volumes caused in part by the capacity limitations of the roadway system. Changes in the Alewife area are likely to result in some increases in traffic volume even without a consciously undertaken effort to increase roadway capacity except in connection with the MBTA ramps to and from Route 2. Due to these capacity limitations, theoretical traffic volume projections for the year 2000 are clearly unattainable without major construction in the Alewife area. A policy decision has been made at both the State and city level to maintain the existing vehicle capacity in the corridor. However, since the potential for increased traffic volumes does exist care should be taken to ensure that through vehicles are prohibited from entering residential neighborhoods.



0 400 800 1200

scale in feet

Exhibit 1

Alewife Traffic Volumes
1975–1977 ADT

several sources

Volumes on Other Local Streets

Cedar St.		3,500
Pemberton St.		2,000
Harvey St.		1,000
Brooks St.	E. of lake	2,000
Brooks St.	W. of lake	3,500
Sherman St.	N. of railroad	6,000
Sherman St.	S. of railroad	8,000

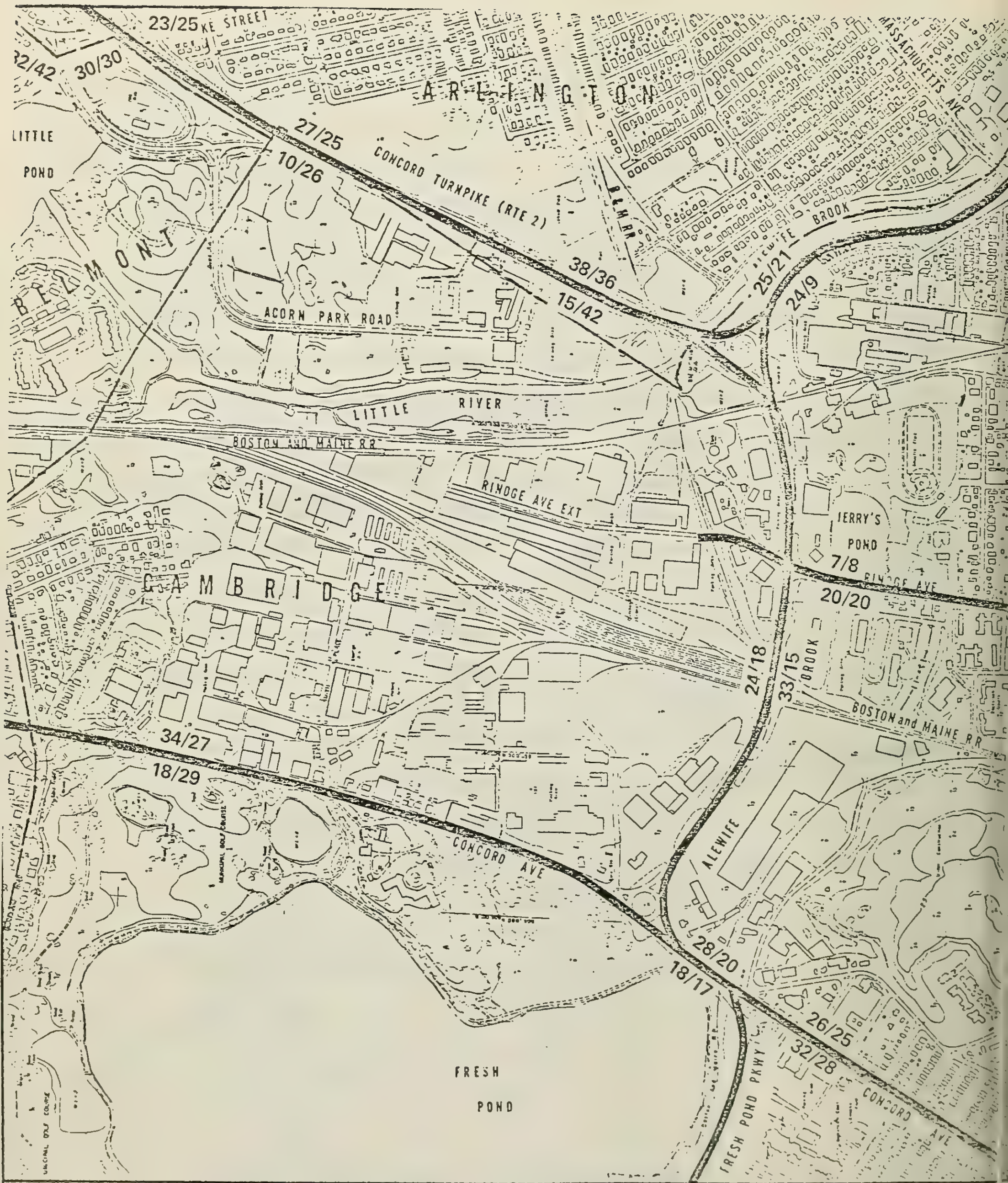


Exhibit 2

Average Travel Speeds
1975
Source: FS&T

Average Speed A.M./P.M.

EXHIBIT 3

HISTORICAL TRAFFIC VOLUMES

ROUTE 2:	1951	23,000	1975+
W. of Alewife	1955	27,500	
	1960	33,700	
	1972	43,000	44,500
ALEWIFE:			
N. of Concord	1951	23,000	
	1955	24,000	
	1972	46,000	46,000
LAKE ST.			
N. of Rt. 2	1963	8,200	12,000
S. of Rt. 2	1963	5,000	9,500
CONCORD AVE.	1970	16,000	17,600

Traffic Gateways, Capacity and Through Routes

Nothing protects the residential neighborhoods of the Alewife area from traffic intrusion more than the existing natural and man-made barriers to through traffic. This applies to neighborhoods in Arlington and Belmont as well as Cambridge.

The principal natural barrier is formed by the Little River and Alewife Brook Parkway, which affect parts of all three communities. Other barriers include Fresh Pond and MDC reservation land. Major man-made barriers include railroad rights-of-way, limited access highways (Route 2 and parts of the MDC parkway system) and some large tracts of private land. While many of these barriers could be breached, the environmental and monetary costs involved allows few opportunities.

Exhibit 4 shows major barriers to traffic. Most residential areas are provided access by a single minor arterial road that traverses the neighborhoods. What happens in all cases is that these roads are used as short cuts by through traffic, in most instances to the limits of their traffic capacity. It is usually an intersection with a major arterial route which limits capacity on these roadways to levels below the capacity of the roads themselves. Lake Street, Blanchard Street and Rindge Avenue fall into this category.

Where physical barriers do not effectively protect a neighborhood, traffic penetration has been avoided by the judicious use of one-ways and turn restrictions. This type of approach has proved effective in the Fresh Pond area bounded by Concord Avenue, Huron Avenue and Fresh Pond Parkway.

Because of the numerous barriers to travel in the Alewife area, the overall capacity of traffic travelling into and through the area is limited by the capacity of the major entering roadways. Exhibit 4 shows these gateways and the number of existing and projected traffic lanes. There are ten lanes of traffic entering the Alewife area (including Rindge Avenue). Except for the Route 2 gateway, all of the entering roadways are controlled by traffic lights which physically limit the volume of traffic that can enter the area.

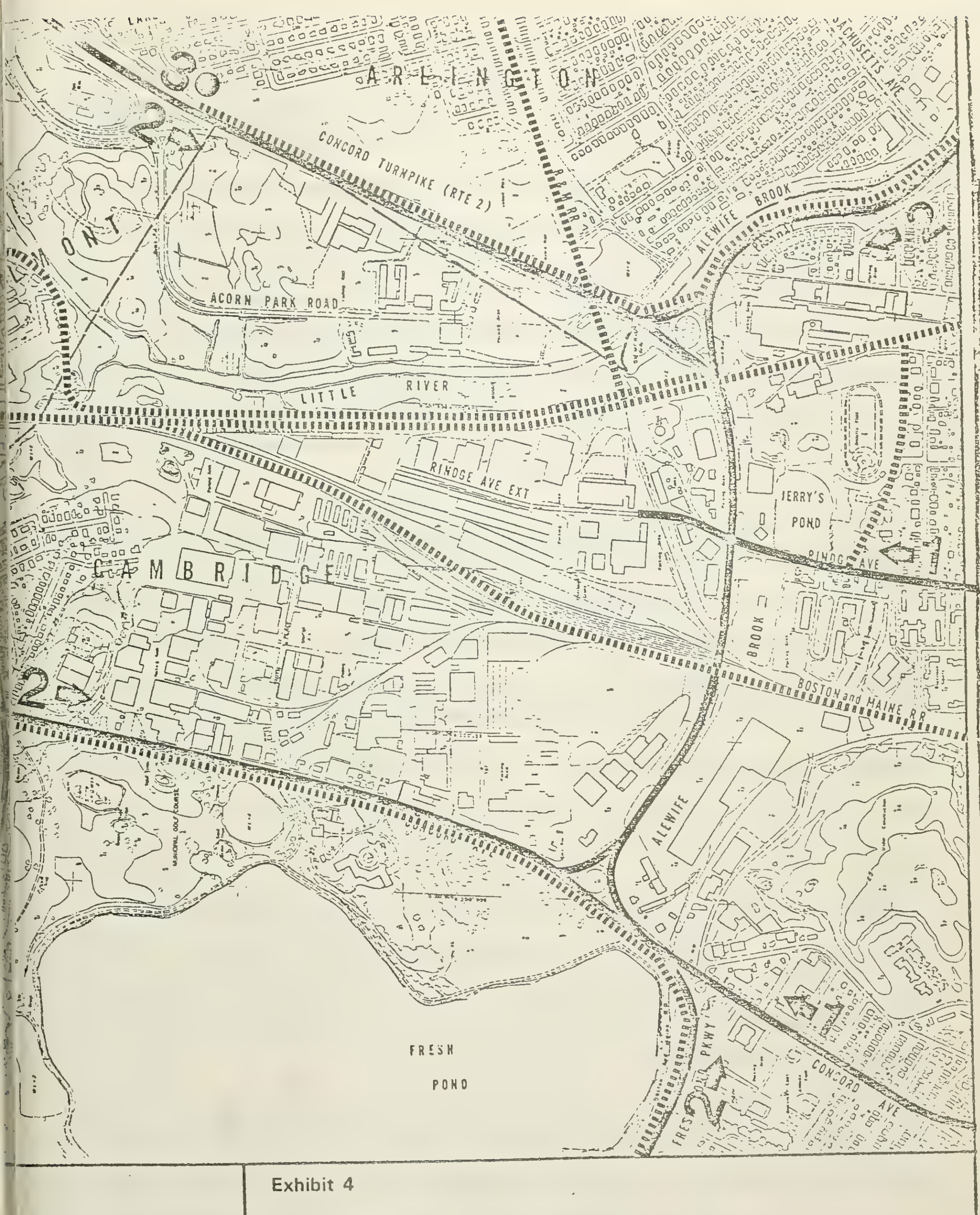


Exhibit 4

Traffic Barriers

Number of Traffic Lanes Entering Alewife 1977

Projected Lanes

The question facing the Alewife area is this: If traffic improvements within Alewife are made which increase capacity, is there reserve capacity at these gateways that will allow through traffic volumes to increase. Along the MDC parkways, it appears that Huron Avenue in the south and Mass. Ave. to the north are limiting points in the total flow of traffic. At each location, there is a significant cross-flow which reduces the amount of green time available to parkway traffic. On Concord Avenue west, the extremely heavy cross-flow at Blanchard on the west and the series of traffic signals on the east toward Harvard Square effectively limit the amount of traffic that can enter the area. From visual observation, Huron Avenue appears to be as much of a restriction to flow as the Rindge Avenue intersection and the Dewey/Almy Circle.

Route 2 has the greatest potential for an increase in traffic created by the addition of the ramps to the "T" garage. This additional capacity is in fact necessary to handle the extremely heavy peak flows of traffic expected to and from the west. The minimum build design for the Dewery/Almy Circle has the flexibility to be used as the inbound control point. The outbound left turn to Route 2 will become the critical factor in the system.

There are sufficient restrictions to the flow of traffic in the Alewife area that will remain even with the construction of new ramps and redesign of the rotary intersections, thus, total traffic volumes will not increase dramatically. But, even though construction proposals do not increase the total number of traffic lanes in the area, they may produce some increase in local capacity. With no additional capacity provided for Concord Avenue east, Fresh Pond Parkway at Huron Avenue or at Concord Avenue west, additional capacity to the north and west should be of greatest value in serving local development.

Most residential streets in the Alewife area are protected from the impact of through traffic. It would be virtually impossible to totally prevent non-local traffic from the access roads since they serve some large traffic generators such as stores, apartment buildings and industries. It will be a test of the traffic proposals that are made in the future that they do not change

the status quo of existing neighborhoods. They should be able to serve new development within the context of a roadway network that does not adversely affect established residential areas.

An interesting characteristic of the main roads through the Alewife area is that there are relatively few dwelling units adjacent to these roadways. Route 2, the MDC parkways and Concord Avenue west account for about 3.5 miles of roadway in the Alewife area, yet there are only 226 dwelling units within 300 feet of any of these roadways and only 411 units within 500 feet. (This excludes Rindge Towers which, because of its height and construction characteristics, is less affected by roadway noise, visibility and fumes.) These limits were arbitrarily chosen, but they represent a reasonable limit to visual and air quality impact.

It is significant that nearly all of Route 2, Alewife Brook Parkway south of the Dewey/Almy Circle, and Concord Avenue between the rotaries (the most heavily travelled sections of roadway in the study area) have few residential abutters. The largest concentration of homes are in the Fresh Pond neighborhood, the Whittemore Avenue area and East Arlington. Route 2, on which traffic volumes are likely to increase most significantly, traverses the lowest density residential area in Alewife.

The Proposed Alewife Station and Garage

The new Alewife Station, one of the most important on the Red Line extension, will have an impact on the Alewife area in several ways. Most obvious at the present time is that planning for the station has resulted in a considerable amount of community concern and involvement in anticipating the changes that a transit station is expected to produce in the area.

The impact on total traffic volumes is not expected to be a major one. The main reason for this is that part of the overall station strategy calls for direct ramps to and from Route 2 where the bulk of automobile users are expected to come from. Whether the station will in fact effect a permanent reduction in traffic volumes by diverting commuters to the Red Line away from their cars remains to be seen. Experience elsewhere has shown that a reduction in traffic volumes that resulted from construction of new transportation facilities is temporary, with traffic volumes building up to their original level after a period of time. There is no reason to expect that the situation will be different here under today's conditions. However, with some inevitable changes in gasoline availability and national energy policy, there is a stronger likelihood that in the future, any reduction in traffic volumes might at least be longer-lasting.

Vehicles using the station and garage will constitute only a small part of total local traffic. Exhibit 5 shows that a total of 62,500 vehicles per day now approaches the Alewife Station area. The "T" is expected to produce about 3,000 trips, which represent less than five percent of existing approach volumes. Thus, under any conditions, with diversion or not, the total impact of the MBTA station on traffic will not be large. Exhibit 6 shows existing peak hour traffic volumes in the Alewife area and the additional traffic that the "T" is expected to produce on major streets. Most of the traffic is oriented toward Route 2 and only a minor amount is toward Cambridge. The only really important movement that would have some effect on Cambridge would be the northbound Alewife Brook Parkway traffic that would exit via Rindge Avenue Extension. Overall, the "T" is not expected to materially affect traffic volumes east of Alewife Brook Parkway.

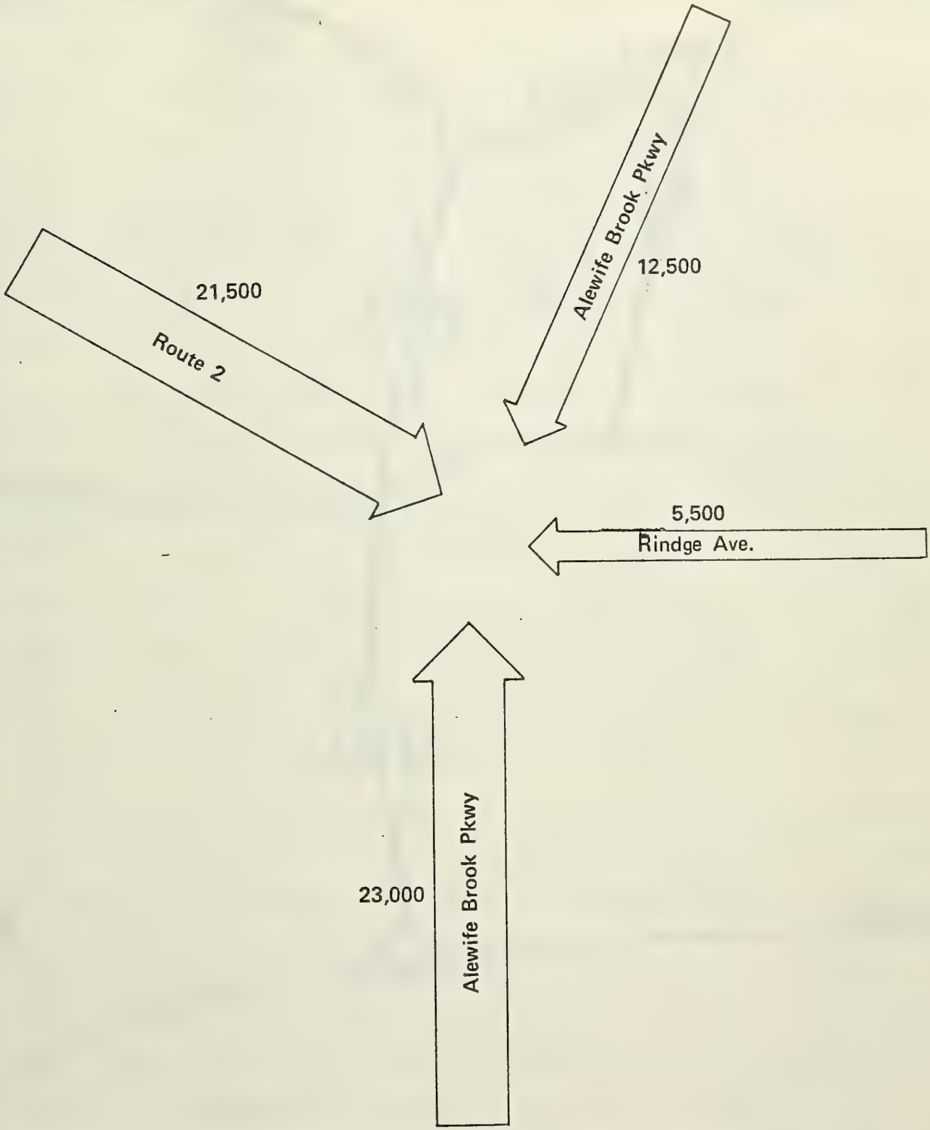


Exhibit 5

Approach Volumes to the T Area

Numbers = Volume per day, 1977
Total Approach Volume, 1977 = 62,500
T Generation = 3,000
T Generation = 4.8% of 1977 Approach Volume

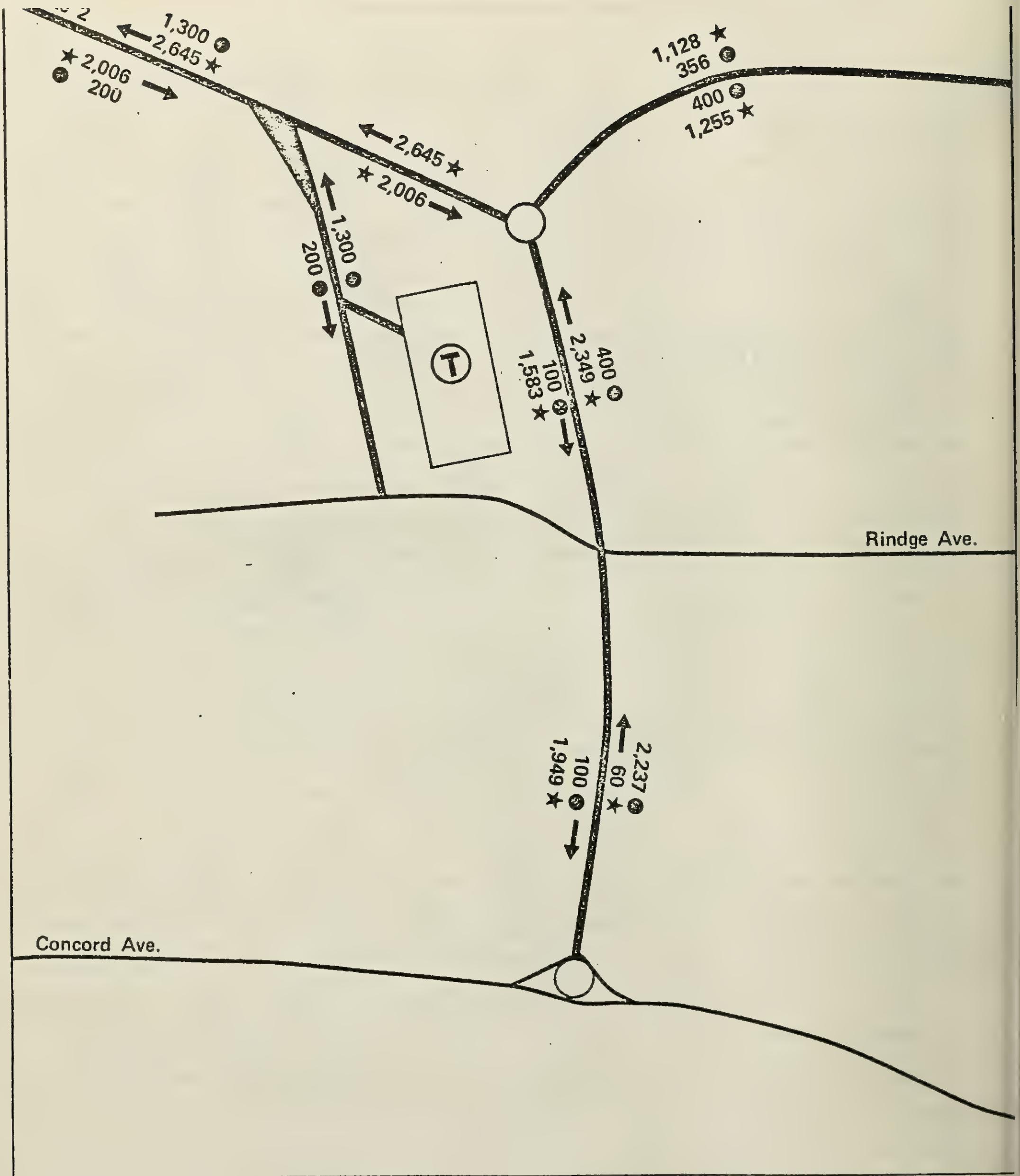


Exhibit 6

Peak Hour Flow (5:00 – 6:00 P.M.)
With T Add-On

Numbers with ★ = Existing Peak Hour Flow
Numbers with ⊖ = T Traffic

Potential Transit Use

Public transportation now accounts for 8.5 percent of all employee work trips to the Alewife area but could increase to between 15 and 25 percent with the completion of the Red Line extension. The further out toward Route 128 the line is built, the greater the potential use of transit. If future development is highly oriented toward the type of uses which rely most heavily on public transportation, and if such development were to occur adjacent to the new subway station, the percent of transit trips could be even higher.

Home offices or light industrial use close to the station entrances would produce the highest proportion of transit trips and would offer the greatest potential for reducing peak hour traffic volumes generated by development in the Alewife area. The State Street South complex, located at the North Quincy Red Line transit station, provides an insight as to what might happen at Alewife. An insurance company, 500 feet away from the station, claimed 25 percent transit use by employees, while a bank headquarters located 1,000 feet away claimed 13 percent use. Industrial establishments in the area generally had transit uses of less than ten percent. Exhibit 7 shows transit use at selected locations.

Transit use will also be affected by the long-term effects of fuel availability and government regulation of automobile travel. Recent increases in gasoline costs did not produce any decrease in automobile travel and it is doubtful that even sharper increases will materially affect mode of travel to work. Fuel shortages which might result in gasoline rationing and government regulations to reduce the use of automobiles for work and other travel, will result in higher transit use. But such transition is not going to occur on a voluntary basis. For the purposes of this analysis, therefore, it was decided to estimate potential transit use based on the current convenience of automobile travel. Furthermore, greater fuel economy and more carpooling and van pooling represent a transition which will take years. It is likely that small cars will become more popular before there is a massive switch to public transportation.

EXHIBIT 7

EXTENT OF TRANSIT USE - SELECTED LOCATIONS

Location	Type of Facility	Closest Dist. to T Transit	Transit Use
North Quincy	Insurance Co.	500'	25%
North Quincy	Bank Office Bldg.	900'	13%
North Quincy	Warehouse Appliance Repairs	5000'	11%
Newton	Warehouse Admin. Offices	500'	37%
North Cambridge	Office + Mfg.	over 1 mile	8.5%
East Cambridge	Manufacturing	200'	55%
East Cambridge	Office Building	400'	19%
East Cambridge	Composite		23%
North Cambridge	Composite		8.5%

I... not expected that the Alewife area will become a major focus for non-work trips. The one type of use which produces the most number of midday trips -- shopping-- inherently produces automobile trips, particularly at locations such as Alewife. The development options which stress new commercial and retail space have been downgraded since they do not appear to fulfill community objectives from traffic and other persepctives.

In sum, transit use in the area can be expected to at least double merely by the extension of the Red Line. Transit use as a percent of total employee trips could even triple or quadruple from the present level of 8.5 percent, depending on the type and location of new development and State and Federal restrictions imposed on automobile use. The imposition of strict environmental standards and concomitant higher vehicle costs -- initial and operating -- will most likely hasten carpooling prior to a diversion to the "T".

Transit Area Coverage

Because of alignment and station spacing of the Red Line Extension, part of North Cambridge is accessible to three proposed subway stations. Residents in the Cedar Street area who are willing to walk the half-mile (about ten minutes) to a transit station will have their choice of Alewife, Davis Square or Porter Square. In plotting the walking distances from the Alewife station, the ten minute contour line falls well within the ten minute contour lines drawn for Porter Square or Davis Square. Exhibit 8 shows five and ten minute walking distances.

Since transit users will tend to walk in the general direction of their destination, actual usage will depend on user preference, the rate structure that is established for the extension, and the feeder bus system that evolves after the stations are in place. This means the Alewife station impact will probably diminish rapidly as one moves away from the station toward Mass. Ave.

Because of the open space between the station and the residential neighborhood of East Arlington, a relatively small number of homes will be within the ten minute walking limit of Alewife station. If a strong pedestrian link is provided along the railroad tracks toward Arlington, a slightly larger service area

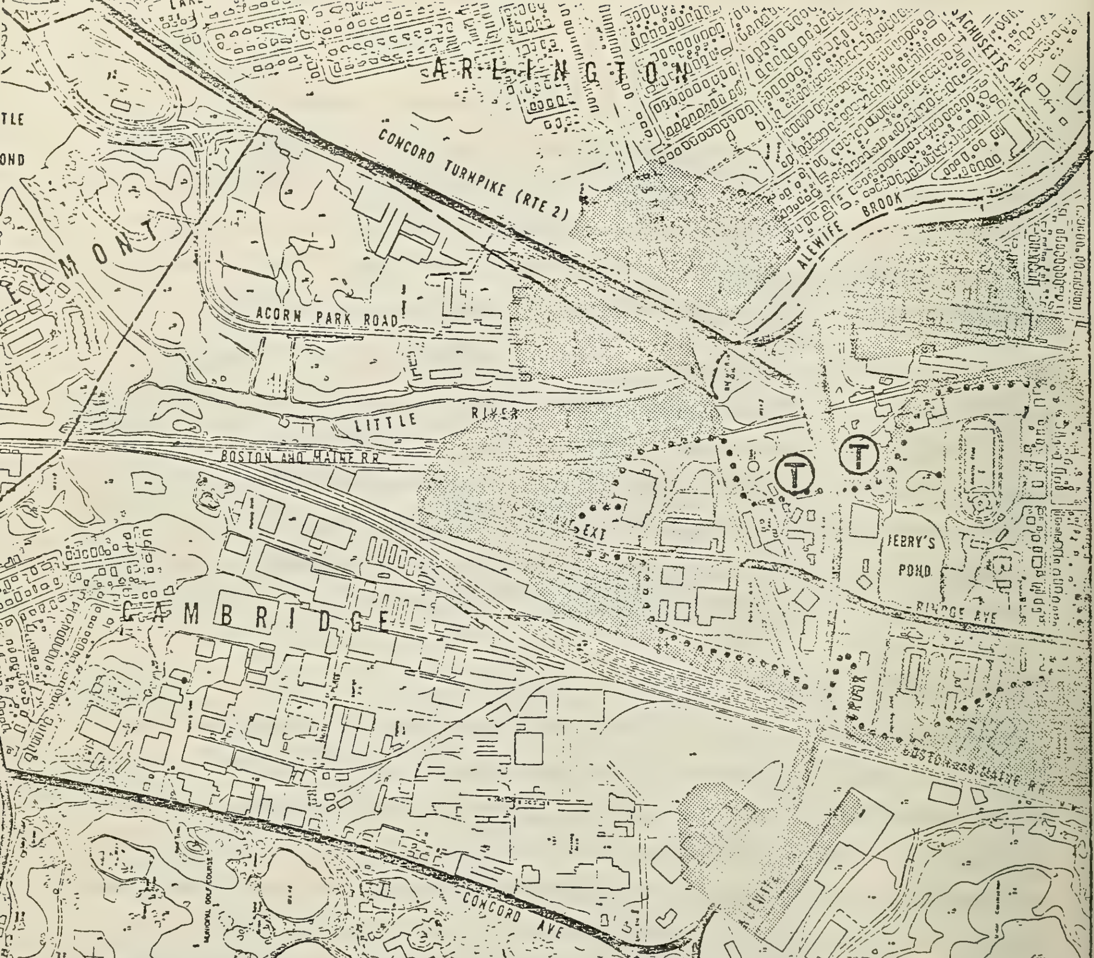


Exhibit 8

Walking Distances to T

Within 1500′ (5 minutes)

Within 2400′ (10 minutes)

16

might be established since the residents in the interior of the residential area would otherwise have to walk to Mass. Ave. for bus service which may not be as convenient.

The Whittemore Street portion of North Cambridge is now within the ten minute walking distance of the Alewife station. Assuming there is some pedestrian connection directly across the Grace property, much of this area will be a five minute walk.

Thus, it appears that the greatest number of new transit users of the Alewife station will be generated by business and industrial land uses in the area. Because of its strategic location in the regional roadway system, Alewife is likely to be heavily used as a bus drop-off area and by park-and-riders. While much of the ridership projected for the Alewife station is composed of bus riders and people arriving by auto for trips in toward Boston, the station has the opportunity to reach its maximum utilization by attracting outbound riders to nearby office and industrial uses.

Bus Route Changes

The MBTA has not as yet determined what revisions will be made to bus routes in the Red Line Corridor. A large number of current bus riders passing through the Alewife area are destined for Harvard Square for the purpose of transfering to the Red Line. The new Red Line stations at Alewife, Arlington Center and Arlington Heights are expected to intercept a large percentage of these riders. Some of them, in fact, will be able to walk to a transit station and not use a bus at all. Insofar as service to Cambridge residents is concerned, care must be taken to ensure that headways for local service are not substantially reduced. It can be assumed that those bus routes that travel on a "limited stop" basis through Cambridge would not continue to Harvard Square merely to intercept the Red Line, but would terminate at one of the new stations.

What is likely to happen in the Alewife area is that the straggling routes that now emanate from Harvard Square will be replaced by shorter bus

routes that focus on the closest transit station. As this type of system evolves, it will be important to continue to provide surface bus routes for intra-Cambridge travel.

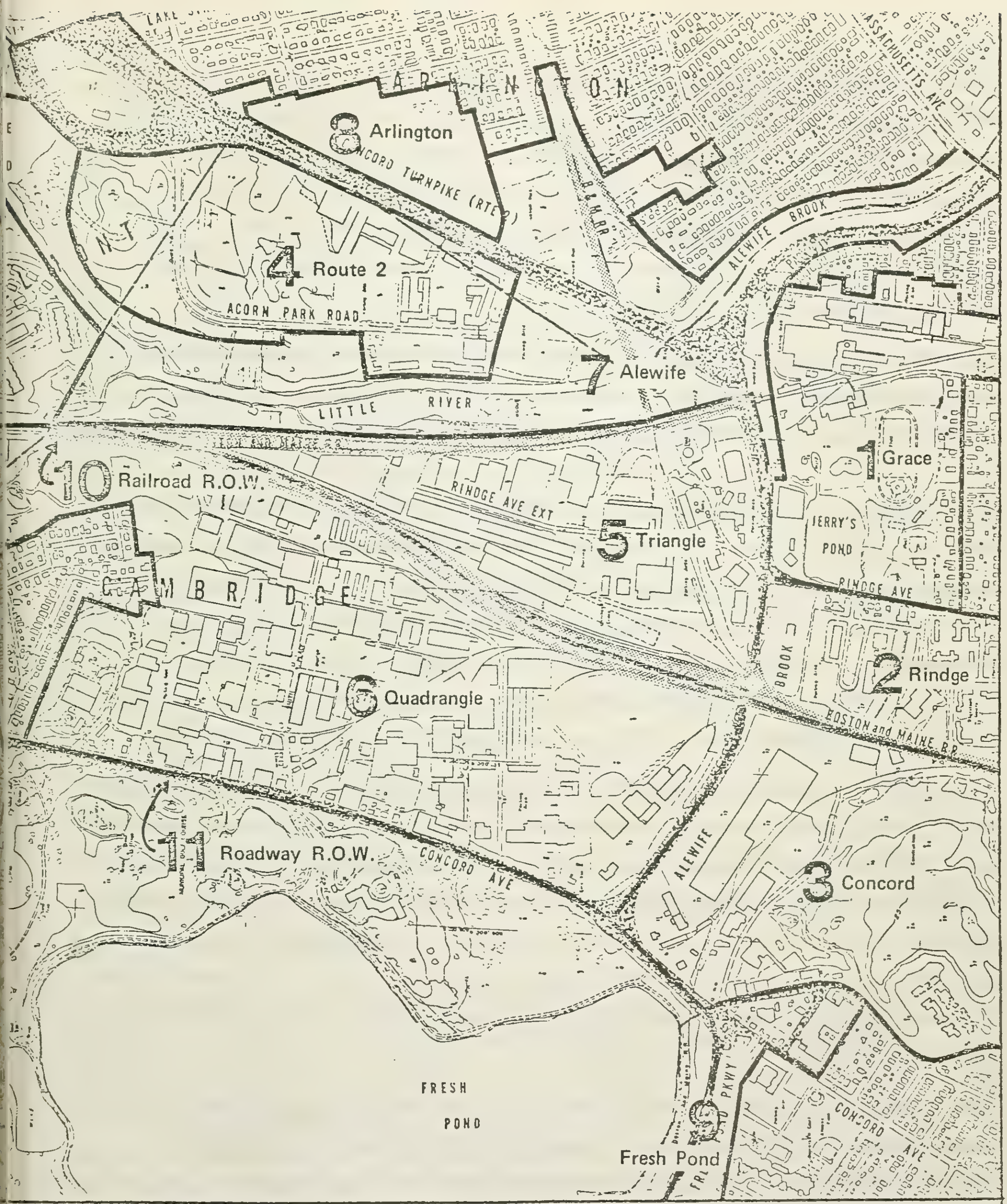
In Arlington, the several bus routes that terminates at Arlington Center are likely to continue since they would now provide direct access to the Red Line rather than merely connect to a bus line that subsequently connects with the Red Line.

No important bus route changes are expected in Belmont. Residents are beyond walking distance to the transit stations and will still rely on available bus routes. The only possible changes will be that these bus routes will be oriented toward the closest transit station rather than provide continuous surface travel into Harvard Square.

Access to the Development Sectors

Each of the development sectors in the Alewife Area (see Exhibit 9) has distinctive access characteristics which will encourage or deter consideration for development purposes. In some cases, access is firmly established and is not subject to any major change. However, some access proposals could materially enhance the potential for development and, equally important, could limit the effect of new traffic generation upon the surrounding neighborhoods.

The most distinctive traffic feature of the Alewife area is the heavily used Route 2-Alewife Brook Parkway-Concord Avenue-Fresh Pond Parkway corridor. The string or traffic congestion points running from the Dewey-Almy Circle through a number of intersections to the Charles River makes it difficult to identify one single intersection which is indeed the bottleneck. The intersection of Fresh Pond Parkway and Huron Avenue, which physically stops through traffic to allow Huron Avenue vehicles to move, may be the one. The same condition exists at Rindge Avenue where the major flow is stopped regularly to allow Rindge Avenue traffic to exit. Traffic volumes at Rindge Avenue are higher than those at Huron Avenue and the approaches are narrower;



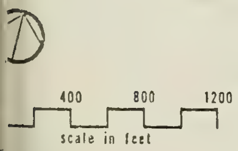


Exhibit 9
Development Sectors

thus, it is generally assumed that Rindge Avenue is the limiting point in the North Cambridge/Alewife system. It also stands to become the most impacted by the Alewife Station and Garage because of the non-Route 2 traffic that would exit onto Alewife Brook Parkway. Concord Avenue between the rotaries is also critical because some of the highest volumes are recorded here. The handle of this barbell carries traffic that splits into two directions at each end.

Existing and potential features of each of the development areas in which change is expected to occur are discussed below. Each section discusses the effect on general traffic and the likely effect on nearby neighborhoods.

The Triangle -- Development of the Triangle hinges upon the new ramps from the Alewife Station to Route 2. The existing access into the site via Rindge Avenue Extension is not capable of serving a large development. The Alewife Station is expected to place a substantial new load on the intersection of Rindge Avenue Extension and Alewife Brook Parkway. Even with Route 2 connections, the Triangle area is expected to draw a number of trips from Alewife Brook Parkway arriving from the north and east.

A possible connection between the Rindge Avenue Extension and Smith Place would increase the Triangle's potential by creating a new entrance from the west that might also attract some traffic from the south and east in order to avoid the Rindge Avenue/Alewife Brook Parkway intersection. The development of the Triangle is, in fact, expected to be limited by intersection capacity to a larger degree than other development areas. Conversely, the Triangle has the greatest potential for development that relies on public transportation.

The Triangle area may create a demand for travel through the North Cambridge neighborhood to a greater degree than other locations. Increased travel through the North Cambridge area should be discouraged and all access designs should take this objective into consideration. The Rindge Avenue/ Alewife Brook Parkway intersection is expected to contain design features

which will restrict the use of Rindge Avenue for access. Because Rindge Avenue and other streets in North Cambridge do provide natural short-cuts for some of the more congested arterials, additional means of restricting through travel within North Cambridge may be required in addition to the design constraints on Alewife Brook Parkway itself.

Grace Property -- Access to this development area is now via Whittemore Avenue at its intersection with Alewife Brook Parkway. The property does have a right-of-way extending to Rindge Avenue but neither Grace nor the North Cambridge neighborhood is interested in seeing this access developed. The Grace Company has made a strong effort to provide a new access point into the site at the Dewey-Almy Circle which would permit the closure of Whittemore Avenue at Alewife Brook Parkway.

From a traffic standpoint, the Grace property would have less impact on North Cambridge than development of the Triangle. The reason for this is obvious. If Grace is provided access onto Alewife at the Route 2 intersection, then two-thirds of site traffic would head north or west directly away from the site, without impacting the section of Alewife Brook Parkway to the south. The same development in the Triangle would cause more problems at the Rindge Avenue intersection since northbound traffic would exit onto Alewife Brook Parkway at a critical location. Triangle traffic would also have to contend with "T" traffic exiting onto Alewife Brook Parkway, headed north and south.

The Quadrangle -- The Quadrangle area already contains the largest concentration of development and employment, and is expected to benefit from several traffic improvements that are proposed for the Alewife area. Redesign of the Fresh Pond and Concord Avenue rotaries, a connection into the Quadrangle directly from Alewife Brook Parkway, a route paralleling the railroad tracks passing underneath the Alewife Brook Parkway, and other minor local traffic improvements would all have the effect of making the Quadrangle easier to reach. Redesign of Concord Avenue itself and redesign of some

intersections as well as a redefinition of the interior area to provide more orderly distribution of traffic are also among the proposals for this sector.

The Quadrangle would have less impact on the Rindge Avenue/Alewife intersection by attracting more traffic from Concord Avenue in Belmont, and from Blanchard Road, Concord Avenue and Fresh Pond Parkway in Cambridge. A connection to Route 2 via the Triangle would be very helpful for Quadrangle development. Redesign of the Fresh Pond Circle and Concord Avenue intersections will increase capacity, thus improving access to the Quadrangle.

Belmont would experience most of the new traffic impact. More development in the sectors served by Concord Avenue will have the effect of increasing traffic volumes in Belmont on Concord Avenue and Blanchard Road. Obviously, traffic from the west headed for sites most accessible from Route 2 would tend to approach the Alewife area from the expressways rather than through Belmont Center. It is important to note that traffic congestion in Belmont is limited and it still serves as a bypass for other more congested locations. This makes it more susceptible to change.

Mugar Property -- The construction of the ramps from Route 2 into the Alewife Station and Garage effectively prevent access from the Mugar site onto Route 2. The heavy volumes from the garage ramps combined with Route 2 traffic and the Lake Street interchange will tax the capacity of this area. The development of Mugar will have to be served by existing streets that pass through the residential area between the Mugar property and Lake Street, unless some imaginative way to gain access to Route 2 is found.

The effect will be to limit new construction on this site to the density and type that would not drastically affect the existing residential area. The site cannot develop without street connections to Lake Street. Within the context of existing zoning, the area could develop for residential purposes and in view of the access situation, such development is most obvious. In terms of density, this will be a function of the approach road system and the capabilities of Lake Street to absorb additional traffic.

Except for the impact on the East Arlington neighborhood, little other effects are expected from development at this site. Should the developer come up with an innovative access scheme which would provide direct roads into the site without travelling through the residential area, the situation would have to be re-evaluated in terms of what effect it would have on the Alewife Station and the surrounding approach road system. Such an alternative might be expensive, but should not be discounted if found to be feasible.

Route 2 -- Reorganization of the roadway system serving Route 2 is expected to have little impact on traffic in North Cambridge. The proposals include the elimination of access to property on the south side of Route 2 from Lake Street to the Dewey-Almy Circle which would be substituted for by creating a more accessible interior route serving A. D. Little Company and the nearby commercial establishments. Travel in all directions would be possible via the Lake Street intersection.

West-oriented traffic would use Route 2 without entering the Alewife area directly. Traffic from the north along Alewife Brook Parkway would also be easier to manage. There may be a problem at the Lake Street intersection, but there seems to be space within the existing interchange to provide the necessary traffic capacity.

Concord-Fresh Pond Sectors -- There are no significant development proposals being made for these areas. The former city dump is considered suitable for recreational development only. The dormant state of the dump site, and the existing Alewife Shopping Center, leave few prospects for growth. Some additions to the Alewife Shopping Center either as free-standing units or attached to the shopping center are possible. The Fresh Pond sector consists mostly of strip commercial development oriented toward the heavy flow of traffic. The Lower Alewife/Fresh Pond Area is the least accessible. It has fewer access options and the highest volumes of traffic. No changes are expected in this area which would have the effect of increasing traffic volumes.

Rindge -- There are no designs for the Rindge sector which would have an effect on traffic. Development proposals in this area are oriented toward consolidation of the recreational areas making them more accessible to the neighborhood. This would also include providing access from the North Cambridge neighborhood to the east portal of the Alewife MBTA station. If there are any commercial development proposals for the Rindge sector, access would probably be provided via the Grace access. Rindge Avenue is not considered to be a suitable location for new development because it is a narrow road, not easily widened or otherwise susceptible to improvement.

Traffic Characteristics of Alternate Land Uses

Traffic impacts in the Alewife area can be controlled to some extent by carefully choosing those land uses that are least likely to have an adverse effect. This process must also consider the location as well as the type of land use.

The importance of locating transit-oriented uses adjacent to the new subway station cannot be overemphasized. If the area is to capitalize on the MBTA extension, the densest uses should be encouraged closest to the subway entrances in the Triangle and Grace sectors. It should be recognized, however, that any type of development in the Alewife area will create a large demand for automobile access and this aspect of development cannot be overlooked. This section looks at a few combinations of land use and location which would produce distinctive traffic patterns.

Retail -- Retail trip generation varies according to shopping center size and tvpe. Retail space devoted to an exclusive specialty store would generate far fewer trips per square foot than stores constituting a neighborhood or sub-regional convenience shopping center. In turn, convenience center trip generation would be based on the degree of accessibility by customers on foot. If a large amount of housing were to accompany a convenience shopping center, then the total automobile trip generation would be lower. It would then be reduced even more for a smaller shopping center than for a larger one because a larger one would draw from a wide enough area to require more automobile use.

A large-scale retail use will be the least desirable from a traffic point of view. A large-scale retail development is unlikely to be transit-oriented, thus nullifying the advantages of the Alewife Station. While shopping centers generate traffic throughout the retail day and evening (a shopping center open at night peaks after supper), they still generate high volumes of traffic during the evening commuter rush hour. During the morning, however, they are not a factor.

Hourly and daily distribution could also be a problem with a retail development. Saturday is always the busiest day of the week, there is a lot of nighttime traffic, and seasonal peaks at Christmas and Easter may produce several weeks of above-average traffic volumes. These would have an effect on residential areas.

A wide variation in retail generation could occur in the Alewife area. If retail construction is limited only to support for proposed hotels and office development, then automobile trip generation on a per square foot basis would drop. There is a need (or market) for some retail, but emphasis should be placed on type and location to reduce if not totally eliminate adverse traffic impact.

Offices -- In office development, the type of office building and the mix of tenants could have an effect on trip generation on a daily basis, particularly during peak hours. A home office for an insurance company tends to produce a very high rate of peaking with few midday trips. Groups of small offices would have a reverse effect with more trips made during the day by clients and customers and fewer trips made during the peak hour on a per employee (or per square foot) basis because of the greater flexibility of time and other factors inherent in smaller offices. A scientific research and development facility included within the office category might have large areas devoted to equipment which would reduce the number of employees per square foot of building, thereby reducing the overall trip generation.

Residential -- In the residential category, housing for the elderly produces far fewer trips per unit than low or moderate income housing which, in turn, is different from market rate housing. Obviously, the size of a dwelling unit would have an effect on trip generation.

Residential development would produce peak volumes in an "opposite" direction of normal peak hour flows in the area. For example, in the Triangle assuming the directional distribution used for other traffic, about two-thirds of evening peak hour volume would turn into Rindge Avenue Extension or the

the new Route 2 ramp. This would have a low impact on Alewife Brook Parkway peak hour flows.

Housing is a big question mark in regard to transit use. Apartment developments adjacent to the Green Line and other transit facilities in the Boston area do not generate a large volume of transit users. The excellent highway accessibility of this key area to Route 128 and other nearby large employment centers does not guarantee a captive transit market for the "T". Reverse auto commuting, even from apartments in downtown Boston, is common.

<u>Industrial</u> -- Industrial use can be expected to generate a lot of "T" trips if experience elsewhere in Cambridge is any example. The combination of moderate wages, and often a concentration of home locations within the existing transit area may be the reason for this. It would also produce the fewest number of midday trips. Industrial uses produce high peak hours, but also have the capability for spreading out these trips. Existing industrial businesses already have a medium range of work schedules and have the potential for even more staggering of work arrivals and departures.

<u>Hotels/Motels</u>

Over the course of a day, hotels generate about ten trips per room, but they do not have sharp peaking characteristics. During the evening commuter rush hour, motels generally produce less than one trip per room and most of this traffic is generated by public facilities rather than by the overnight accommodations themselves. Hotels/motels consequently are one of the least offensive types of traffic generators. They produce very few trips during the morning rush hours, have a fairly small number of deliveries during the day, and while they may have public meeting rooms and conference facilities, they do not create serious traffic problems, nor do they generate heavy traffic during the busiest parts of the day.

Employment Densities for Evaluating Alternative Land Uses

Various land uses have predictable levels of employment and these have been used in estimating future trip generation in the Alewife area. Employee density information has been obtained from businesses in the Alewife area itself, and from research materials.

Usually, office buildings have one employee for every 200-300 square feet of gross floor area. Professional offices and research involving some equipment sometimes have a lower density, while home office insurance companies, which employ large numbers of filing clerks and typists, may have a higher density. Recently constructed buildings sometimes have a lower density as newly installed tenants usually allow some space for future expansion. As time progresses, however, buildings gradually fill up.

Light industrial uses are comparable to office buildings, but they have a wider range of values. Electronic assembly lines may have as little as 100 square feet of space per employee, while industries with fixed equipment would have a much lower density. For the purposes of planning in the Alewife area, industrial building density has been assumed to be the same as for office buildings.

Retail, wholesaling and heavy industrial uses have much lower employee densities. As a rule of thumb, 500 square feet of retail space will support one employee. For example, there are about 350 employed at the Fresh Pond Shopping Center, which has 185,000 square feet. This comes out to about 525 square feet per employee. Wholesaling activities generally range between 500-1,000 square feet per employee. Hotels usually employ between 1.0 and 1.5 persons per room. For planning purposes in the Alewife area, one person per room is probably a good figure. Industrial land can vary widely, depending on its use. Research data shows between 20 and 80 employees per acre, and for planning purposes in the Alewife area, a figure of 60 employees per acre has been used. The data contained in this section can be applied to the various development options that have been explored to-date and to those that are conceived in the future. Since local

employment is an important objective of new development in the Alewife area, this data can be applied to ascertain the employment generation of the various land use proposals.

Comparison of Alternative Development Schemes

During Phase I of the Alewife Urban Design Study, four 1985 development alternatives were formulated for the purpose of analyzing impacts. The traffic analysis for the development alternatives shows that any of the commercial or office-oriented combinations produce comparable levels of traffic generation. There is some variation among the alternatives, but it is within a fairly narrow range in terms of trips produced per day as well as peak hour trips.

The major exception in the development alternatives is for housing which produces a somewhat lower peak hour volume and one that moves in the reverse direction of peak hour flows on the street -- outbound in the morning and inbound in the evening.

The development options approach to plans for the Alewife area should be put in some perspective. The market analysis, which provided datum as well as high and low estimates, shows a range of nearly three times the low estimate, indicating that it started with a very broad estimate. The alternates were evaluated in terms of total trip production and directional distribution, but in order to keep the final objective within reasonable possibility of accomplishment, only one set of detailed traffic volumes was projected and this was done for Alternative 1, uncontrolled growth.

This does not infer that trip generation estimates for individual land use alternatives should be ignored. Rather, it points out that there is a softness in these projections, particularly because they are based on estimates of land use distribution which in turn are based on estimates of economic activity. What the analyses do reveal, however, is that even moderate development of the land uses in the Alewife area will produce traffic volumes that are beyond the capacity of the existing roadway system to handle. Modifications to existing intersections, new access points and probably continued peak hour traffic congestion are factors which should be recognized as going hand-in-hand with new development.

Evaluation of Alternatives

Alternate 1 -- Uncontrolled Growth

This alternative would have the effect of distributing trip generation over the various development sectors since each landowner would develop at his own pace to conform to market demands. Thus, no one area would receive a disproportionate share of development, although accessibility would play a role. Despite the concentration of office space in the Grace sector, its total generation would not exceed that of other alternatives since office would constitute most of the development. The retail/service establishments proposed for that sector would tend to support the hotel/motel and office facilities and would probably not become a strong attraction for outside trips. The Triangle would attract a significant portion of the projected retail space, probably in the form of a small size shopping center (less than the size of the Alewife Shopping Center). This alternative results in a trip generation r te for the Triangle which would have less impact on traffic than other alternatives.

There would be incremental growth in the Quadrangle. However, because of dispersion under this alternative, the Quadrangle would not show a sharp increase in traffic volumes. The additional traffic generated by the Route 2 and Arlington sectors would have little impact on the Alewife area except that in Arlington, there would be a direct effect on the Lake Street neighborhood.

The uncontrolled alternative has the effect of spreading the development throughout the various sectors and this reduces the impact on any one location. Since Route 2 and Arlington account for more development in this alternative than in others, it has a beneficial effect by keeping traffic on Route 2 rather than causing it to enter the Alewife area.

Alternate 2 -- Residential Community

This alternative would produce more trips than Alternate 1 since the office, retail and hotel/motel square footage would be comparable but No. 2 has an additional 1,000 residential units. The concentration of 1,700 units in the Triangle might encourage use of the Alewife Station. Residential orientation would have the effect of placing a greater commuter load in the Quadrangle area but would decrease trip generation in the Arlington sector and the Route 2 sector.

One major advantage of the residential alternative is that the peak hour flows would be opposite the existing commuter flow in the area. This might allow a significant increase in peak hour traffic volume if the directional distribution is favorable. While the concentration of single use in the Triangle may produce a very high peak, it may be more compatible with existing flows of traffic.

One problem with the Triangle that would occur with any type of development is that it will tend to put pressure on Rindge Avenue because it is a logical connection between the Triangle and the remainder of Cambridge. Services to the area based in Cambridge would probably try to utilize Rindge Avenue. The consumption of Triangle land for residential purposes means that additional development pressures will occur in the Quadrangle which shows an increase in development and traffic over the uncontrolled alternative. In sum, the residential alternative will result in more traffic for the Alewife area than Alternate 1, simply because it calls for more development. However, the incremental change in development is in residential units whose generation may be easier to absorb into the roadway net.

Alternate 3 -- Diversified Employment

This alternative has 200,000 more square feet of office than Alternate 1 and 100 more hotel rooms. The additional hotel rooms are not a significant factor, but the 200,000 additional square feet of office space will have the effect of increasing the peak hour flow. However, increases in density may

produce a higher proportion of transit trips which may offset the increase in building area.

Most of the increase in office footage in Alternate 3 is located in the Route 2 and Arlington sectors. Route 2 is able to absorb and distribute added office space traffic with less of a problem to any neighborhoods or to the roadway system in the area. The addition of 100,000 square feet at the Arlington site, however, is a serious problem if access to Route 2 is not provided. There would have to be a major roadway serving the site from Lake Street. Otherwise, local residential streets would become a network of access roads. From the intersection of any access road to the Route 2/Lake Street interchange, additional improvements may be necessary to handle the peak hour load.

Alternate 3 would also place a heavier load on the Triangle which would have an additional 725 residential units over and above office and retail uses. Trips produced by the residential units would be in the opposite direction of peak hour flows and, thus, are more compatible. However, the Alewife Station and Garage will produce trips that coincide with the residential flows. In the evening, about 300 kiss-and-ride vehicles are expected via Alewife. These will be in the same direction as the homeward bound residential peak. In any event, Triangle development will be tied to the capabilities of the Alewife Brook Parkway/Rindge Avenue intersection which is expected to be one of the limiting factors affecting development in this sector.

Alternate 4 -- Minimum Growth

The small amount of development in the alternative will have a minimum traffic impact. The office space which would be located in the Grace area could continue to operate out of the Whittemore Avenue intersection or could be served by a new access point on Alewife Brook Parkway. The Grace property would probably attract some support retail square footage as well as a hotel/motel which, as noted earlier, has little impact on peak hour flows. Obviously, the minimum growth alternative would have minimum traffic

impact on the area. It is not expected to result in a decrease in traffic volume on Alewife Brook Parkway or other streets.

Summary of Traffic Impacts

Perhaps the best way of evaluating alternatives in terms of trip generation is to compare the total daily traffic volumes that would be generated by each of the alternates. Exhibit 10 shows the total daily traffic for the four major alternates broken down by sub-area. The traffic volumes of Alternate 4 comes closest to representing existing conditions, since this alternate provides for minimum growth. What is significant is that regardless of which alternate is chosen, except for minimum build, additional traffic volumes can be expected. There is not much difference between the various alternates for most of the sub-areas.

Exhibit 11 shows the gross trip generation if the projected average Gladstone figures for new growth in the Alewife area are realized. These values do not take into consideration the effect of the "T" which could reduce these totals by at least 20 percent. The disproportionate trip generation of the retail/shopping category of land use is one reason why this type of use has temporarily been dropped from most development options that have been identified for further study. If there is to be retail/shopping activity in the Alewife area, it must be carefully planned so that it does not detract from potential "T" use and is adequately served by main roads.

The directional distribution is also a major factor in estimating traffic impact. The results of the employee survey, conducted in June of 1976 provided data on where employees are coming from. The results of the directional distribution analysis are shown in Exhibit 12. This directional distribution is based on existing roadway patterns. If there are any changes, such as the Route 2 connection to the Triangle, it would materially affect the route of approach.

Using a combination of trip generation based on Alternate 1 and the directional distribution from the employee survey, an estimate has been made of projected traffic volumes. This is shown in Exhibit 13. For convenience, traffic volumes generated by the "T" are also shown. This exhibit shows that in some cases the projected traffic volumes represent a considerable

EXHIBIT 10

TOTAL DAILY TRAFFIC

	Alternate			
Sub-Area	Unplanned Growth 1	Residential Emphasis 2	Employment Emphasis 3	Minimum Growth 4
Grace	9,600	10,350	9,350	4,650
Triangle	8,450	13,700	10,650	4,000
Quadrangle	24,900	26,650	31,100	18,450
Route 2	11,150	9,550	10,550	8,400
Arlington	1,500	0	2,500	0
Total	55,600	60,250	64,150	35,500

EXHIBIT 11

ESTIMATED GROSS TRIP GENERATION - ALEWIFE STUDY AREA

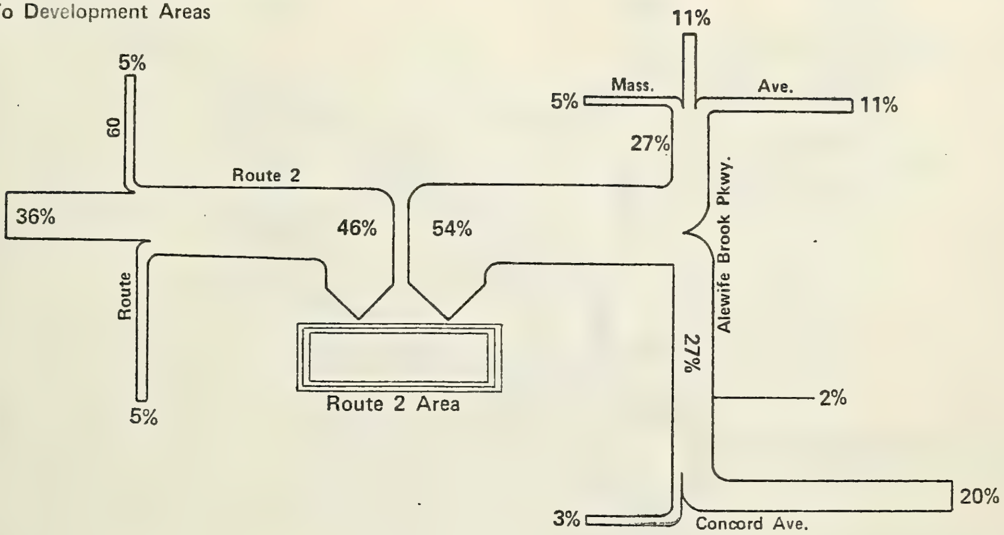
INCREASE BASED ON GLADSTONE DATUM FIGURES

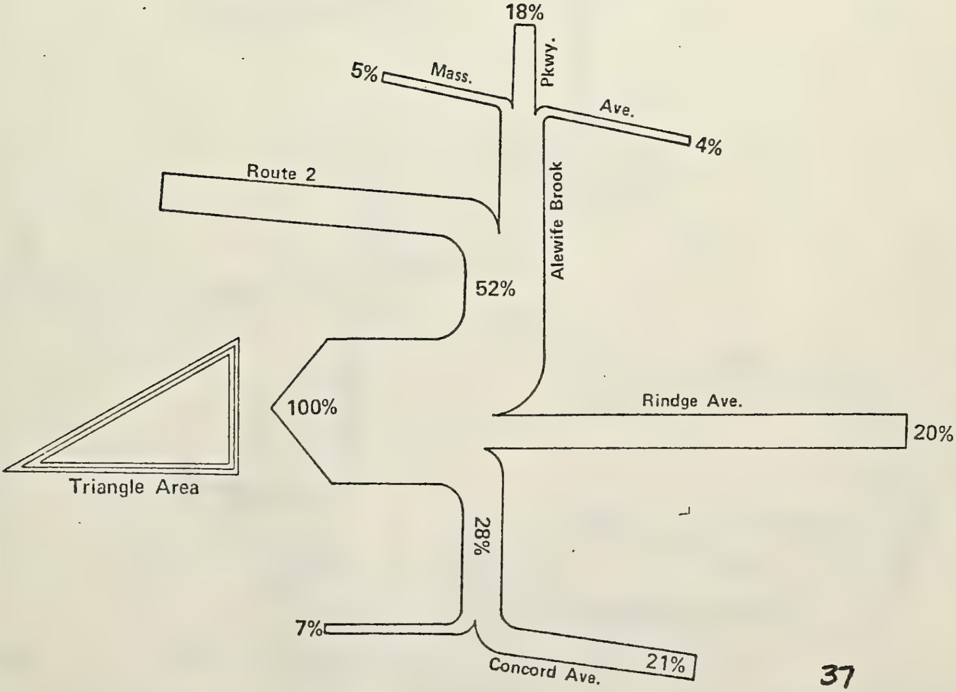
Category	Market Amount	Generation Rate-Avg. Trips	Total Trips Per Day
Residential	925 units	5/d.u.	4,625
Office	300,000 s.f.	11/1000 g.f.a.	3,300
Retail-Convenience	40,000 s.f.	100/1000 g.f.a.	4,000
Retail-Shopping	200,000 s.f.	50/1000 g.f.a.	10,000
Hotel	300 rooms	10/room	3,000
Industrial	20 acres	180/acre	3,600
TOTAL			28,525

Assuming that 20 percent of all trips arrive by MBTA, then the new development will generate about 23,000 trips per day under the uncontrolled alternate if market projections are realized.

Exhibit 12A

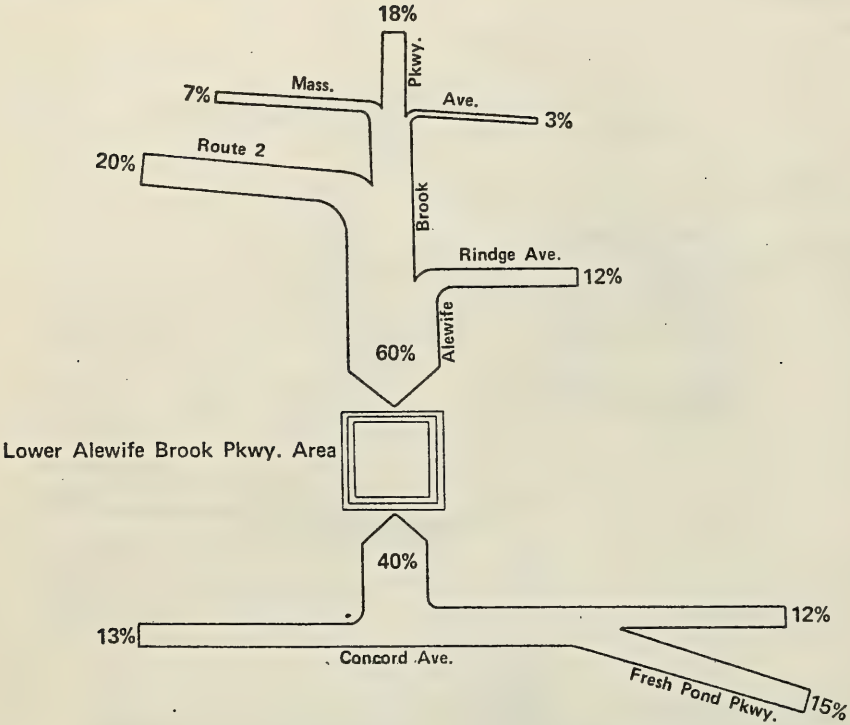
Current Direction of Approach
To Development Areas

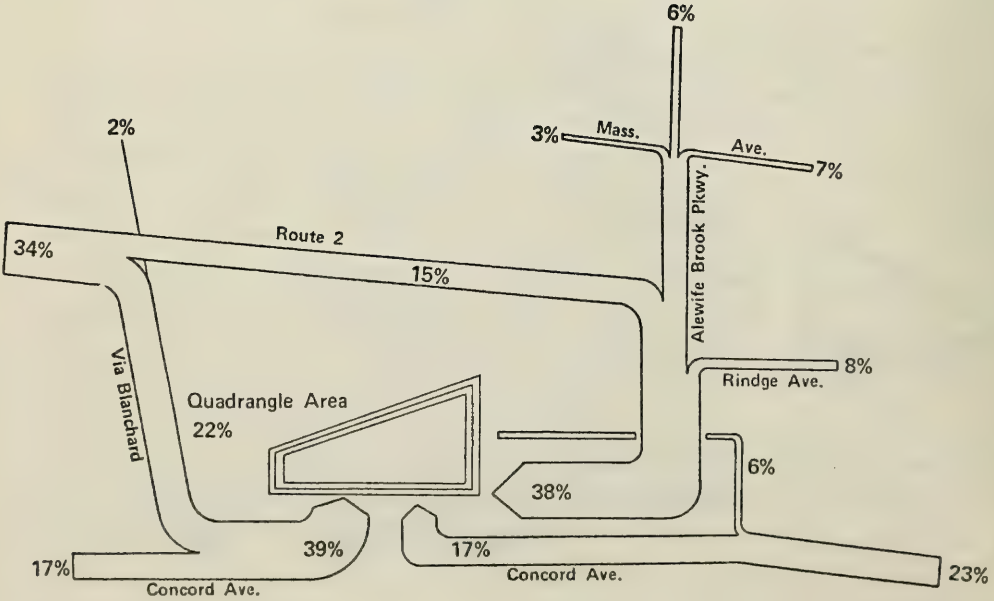




Current Direction of Approach
To Development Areas

Exhibit 12B





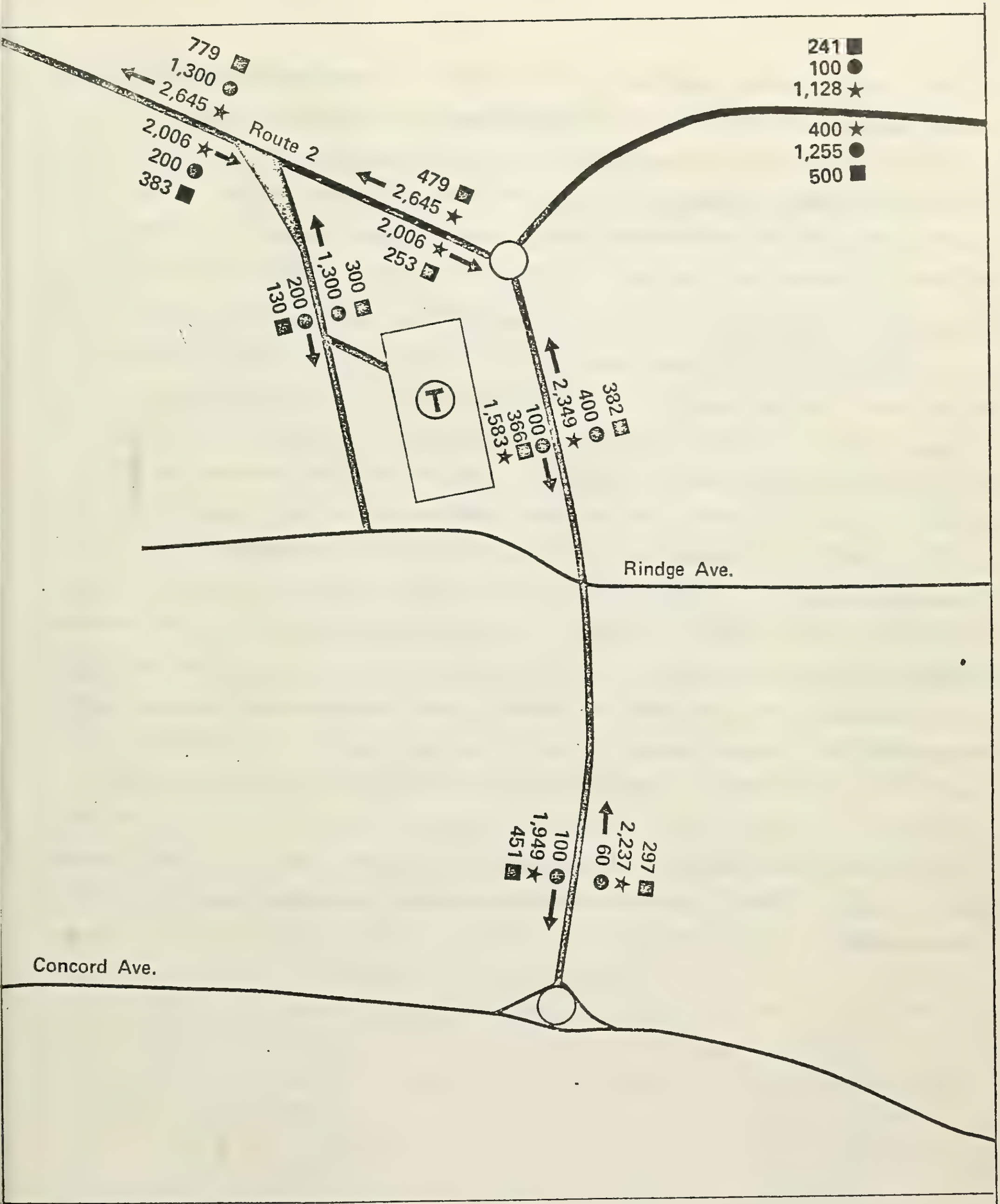


Exhibit 13

Peak Hour Flow (5:00 – 6:00 P.M.)
With T and Alternate 1 Traffic

Numbers with ★ = Existing Peak Hour Flow
Numbers with ● = T Traffic
Numbers with ■ = Traffic Increases Modified Unplanned Growth

increase over existing conditions, while in other cases, the additional traffic volumes are not major. Because the site is expected to attract a large percentage of its traffic from the west and north, the impact in toward Cambridge is expected to be moderate. As noted earlier in the report, however, the problem is how to increase the capacity on major highways to serve new development without encouraging through traffic.

In summary, the Alewife Station and Garage, plus potential new development that could occur, would have the effect of increasing traffic volumes in the area. Major growth would be on the Route 2 connection to the Triangle which is expected to carry about 2,000 cars during the peak hour. This will also be matched by proposals for increasing the capacity of Route 2 between the ramps and the four land section to the west. Insofar as how additional traffic is handled within the parkway system and on Concord Avenue, it is obvious that under existing capacity conditions, much additional traffic cannot be handled. If such a development is to occur, there will have to be some changes in the roadway system that favor the new traffic generators. The task does not appear to be an insurmountable one, even recognizing the intense desire of Alewife residents to keep any additional traffic out of residential neighborhoods and to reduce the level of traffic congestion on major roads. The latter, however, involves the entire region of which the Alewife area is only a small component. Finally, it is possible that the lack of traffic capacity could become the controlling factor in new development.

Proposed Traffic Changes

The requirements of the Alewife station and garage and new development in the Alewife area have generated a number of proposals for traffic changes in the Alewife area. Some of these changes are essential to the successful operation of the subway station, and some of them are essential to the proper provisions for access to major commercial developments. Some proposals have gone through extensive preliminary design phases, while others are simply proposals that have not benefited from careful engineering analysis. The more important traffic proposals and some commentary is contained in the following sections.

Exhibit 14 shows a composite of these proposals. While none have reached the design stage, they are at various levels of refinement. Some, like the Smith Place connector and the Fresh Pond rotary design are in early development stages. Others, like Dewey/Almy Circle and the ramps to the station have received considerable design attention and community review.

Several of the proposed traffic changes are included in the Proposed Minimum Build Alternate of the Mass. DPW. These include changes to the Lake Street interchange, Dewey/Almy Circle, a new bridge over the railroad, ramps to the "T" garage and redesign of the Rindge Avenue intersection.

Route 2/Alewife Station Ramps -- The successful operation of the Alewife station and garage depends heavily on the construction of ramps from Route 2. These ramps will also provide a direct connection to Rindge Avenue Extension, thereby opening up the Triangle for development purposes. The roadway south of the freight cut-off will be characterized by signalized intersections providing access to the station itself as well as to Rindge Avenue Extension. The maximum traffic demand on these ramps will come from the subway station because of its peaking characteristics. On a daily basis, however, new development in Triangle will generate more traffic.

The planning for these ramps has undergone extensive conceptual and preliminary design and is still undergoing modifications and review. However,

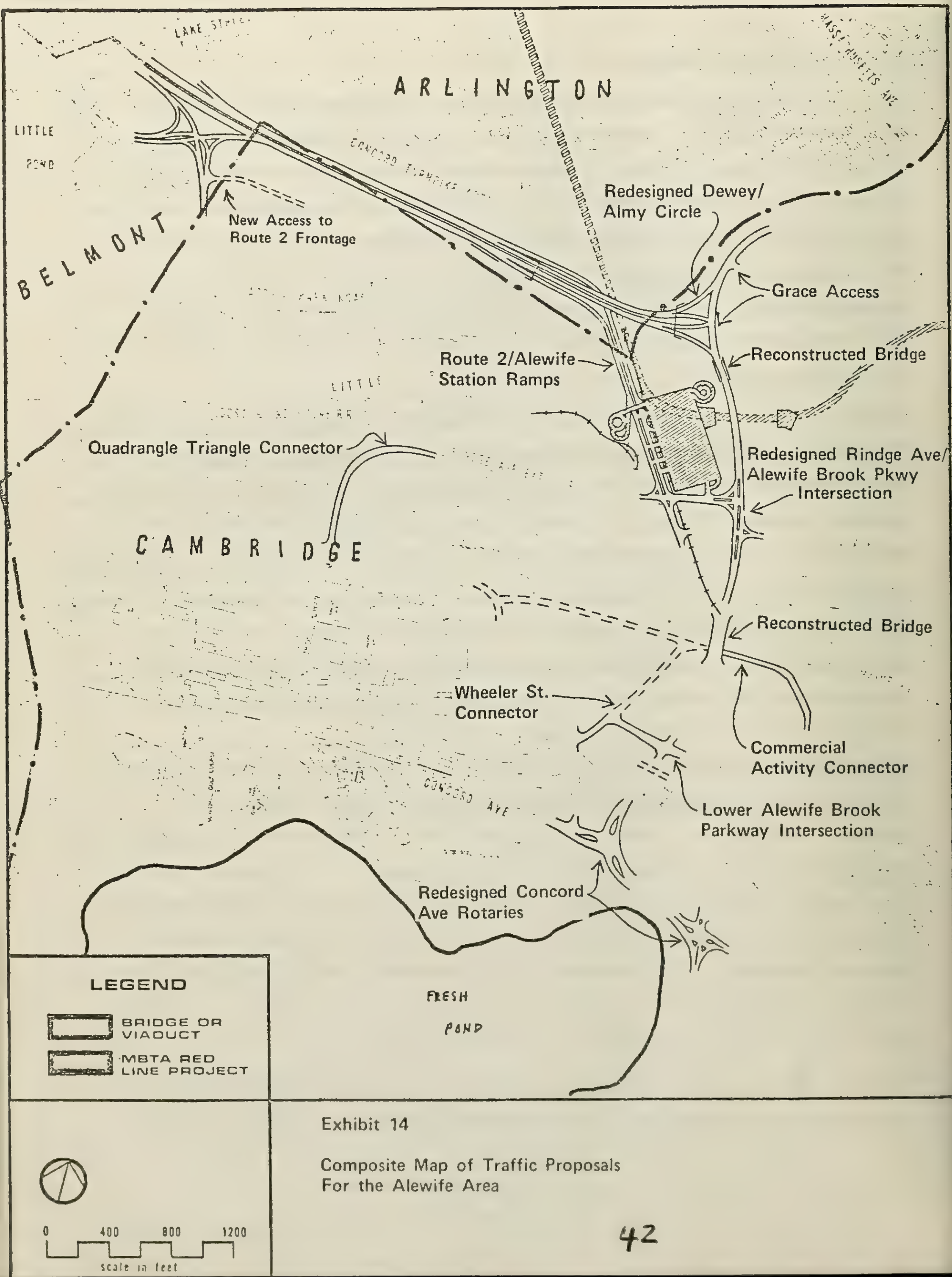


Exhibit 14

Composite Map of Traffic Proposals For the Alewife Area

the basic concept of a direct connection between Route 2 and the subway station and the Triangle has been established at this time.

Bridge Reconstruction -- As part of roadway construction in the Alewife area, total reconstruction of the railroad bridges over the freight cut-off and the B & M main line tracks is planned. Both bridges have weight restrictions which require trucks to approach the industrial area through residential streets, a situation which should be changed. The new bridges are expected to contain the same number of lanes as presently exist on Alewife Brook Parkway, although they are expected to conform more nearly to current roadway design standards for major arterial routes.

Redesign of the Dewey/Almy Circle -- Changes on two sides of this intersection necessitated by the "T" ramps and bridge reconstruction favors the redesign of this rotary which is characterized by inefficient traffic operations and a large number of traffic accidents. The main proposal, called the "minimum build," calls for the construction of a "T" intersection controlled by a traffic signal. The exact dimensions and configuration of approach lanes has yet to be determined by the DPW. The final design, however, because of its potential range in traffic capacity, could have an effect on the Alewife area.

Grace Access -- The W.R. Grace Company appears committed to developing its 26 acre Dewey/Almy site to capitalize on the construction of the Red Line extension. Proposals have been made for direct connections to the parkway system and Route 2 which would reduce the potential impact on abutting neighborhoods. The two proposals which have gone the furthest are full in and out access at the minimum build "T" intersection, or a combination of access at Route 2 and egress out of Whittemore Avenue. Whatever the final design for Alewife Brook Parkway, a new access to the Grace property should be a part of it. At the present time, an entrance directly opposite Route 2 and an exit out of Whittemore Avenue appears to be the most promising alternative in terms of acceptability to the developer and highway agencies. In order to ensure that new development does not

APPENDIX L

EOTC MEMO ON OPERATING COSTS

The Commonwealth of Massachusetts
Executive Office of Transportation & Construction
18 Tremont Street
Boston, Massachusetts 02108

ALAN ALTSHULER
SECRETARY

MEMORANDUM

TO: Matthew A. Coogan

FROM: Thomas J. Humphrey

SUBJ: Rapid Transit Operating Costs

DATE: December 30, 1974

Introduction

All proposed rapid transit lines into Boston would be operated by the M.B.T.A. under current planning. Therefore it is appropriate to derive estimates of the operating costs of such lines from data on present M.B.T.A. operations. The "Statement of Cost of Service and Cents per Revenue Mile" produced annually by the M.B.T.A. Treasurer's Office includes detailed cost breakdowns for each rapid transit route, as well as averages for all routes. Each route now in operation has some unique features, of which it is important to be aware when examining costs. These features are summarized below.

Special Characteristics of M.B.T.A. Rapid Transit Lines

The Main Line (Orange Line) is located about 85 per cent on elevated structure, but the other rapid transit lines include very little elevated track. The cars in use on the Orange Line are 16 to 17 years old, and can carry 48 seated passengers plus 100-170 standees.

The East Boston Line (Blue Line) is located 36 per cent in subway with most of the remainder on surface. Third-rail power distribution is used in 80 per cent of the subway. The remainder of the subway and all of the surface portion have overhead catenary power distribution, not used on any other M.B.T.A. rapid transit line. About half the cars in use are 23 years old, and the remainder are 50-51 years old. The cars can carry 44-48 seated passengers plus 70-120 standees.

The Cambridge-Dorchester Line (Red Line) is located about 70 per cent in subway, 6 per cent on bridge or elevated structure, and the remainder on surface. With the exception of cars purchased for the South Shore extension, Cambridge-Dorchester Cars are 11 years old and can carry 54 seated passengers plus 145-245 standees.

The South Shore extension (Red Line) is located primarily on surface. Unique features of this line include cab signalling, concrete ties, and welded rail throughout. Cars used on the South Shore extension are 5 years old and can carry 64 seated passengers plus 90-150 standees.

Cost Breakdowns

Table 1 summarizes my findings on M.B.T.A rapid transit costs. Individual cost items and the reasons for the formulas shown are discussed in the remainder of the memo.

In 1973 the total operating expenses for all M.B.T.A. rapid transit lines combined averaged $4.0906 per car mile. The range for individual lines was $3.5453 to $4.9429. The most expensive route was the Orange Line, largely due to the high proportion of elevated structure. This structure is expensive to maintain and it limits operating speed, thereby reducing manpower efficiency.

It is unlikely that major amounts of elevated structure would be included in any rapid transit lines currently proposed. Therefore Orange Line costs strongly influenced by elevated structure should not be included in averages calculated in this memo.

A. Train Crew Wages and Fringes

As is the case with commuter rail and bus service the largest expense in rapid transit service is wages and fringes of on-vehicle personnel. Under present union agreements rapid transit trains are operated with one motorman plus one guard for every two cars. Only two or four car trains are now operated on all lines. Motormen and guards are paid by the hour, so it is most appropriate to discuss their wages on this basis. The work rules concerning hours of service, overtime pay, and spread premiums are the same for rapid transit motormen and guards as for bus operators, and are summarized on pages 2 and 3 of my memo on bus service costs dated December 1, 1974. The work day of a rapid transit trainman may include, in addition to time scheduled for revenue trips, time for pulling vehicles in and out of yards, time for travel between endpoints of successive runs, time delayed on line, and cover time. Because of overtime pay, spread premium pay, and pay of trainmen for time other than that spent in revenue service, the effective cost per trainman-hour in scheduled revenue service is much greater than the hourly rate. On the basis of a preliminary examination it appears that in order to estimate the cost of trainmen's wages, excluding fringe benefits, given scheduled car hours in revenue service the hourly rate per man must be more than doubled. As of December 7, 1974 straight-time pay was $6.71 per hour for rapid transit motormen and $6.65 per hour for guards.

The speed and schedule characteristics of the South Shore extension are probably closer to those of proposed extensions than are the same characteristics of any other M.B.T.A. rapid transit route. In calendar 1973 the wages of trainmen on the South Shore line averaged $.4915 per revenue mile.

In addition to the cost of crews operating trains in revenue service, the M.B.T.A. must pay employees to shift cars within yards, and to operate work trains and tow trains. Spread over revenue car mileage the wages of such employees, plus related costs averaged $.0631 per car mile in 1973.

TABLE I

SUMMARY OF RAPID TRANSIT COSTS

ITEM	FORMULA (1973 Costs)	% of TOTAL M.B.T.A. RAPID TRANSIT COST - 1973
A. Transportation		
1) Train Crews	(Hourly wage)X(2.2)X(Scheduled trip time)X [(3 Men)X(No. of 4-Car Trips)+(2 Men)X(No. of 2 Car Trains)]	14.03
2) Misc. Car Service Employees	$6.31 per Car Mile	1.54
3) Station Employees	$70,000.00 per Sta. Per Year	6.92
4) Station Expenses	$10,000.00 per Sta. per Year	1.14
5) Superintendence of Trans.	20% of Items 1-4	4.53
6) Other Trans. Expense	$0.40 per car mile	0.88
B. Maintenance of Equipment		
7) Car Repair	$0.43 per car mile	11.41
8) Indirect Equipment Maint.	$0.14 per car mile	3.34
C. Maintenance of Way and Structures		
9) Maint. of Bldgs, Fixtures and Grounds	$50,000 - $80,000 per Station per year	7.27
10) Maintenance of Track		5.09
Jointed Rail	$.19 per car mile	
Welded Rail	$.07 per car mile	
11) Maintenance of Elevated Structure	$100,000 per 2-track mile/year	2.02
12) Maintenance of Tunnels and Subways	$30,000-$100,000 per 2-track mile/year	1.04
13) Maint. and Operation of signals and interlockers	$25,000-$ 30,000 per mile of track per year	3.86
14) Maint. of Power Distrib.System		0.68
Third Rail	$0.015 per car mile	
Catenary	$0.10 per car mile	
15) Superintendence of Maint.	10% of items 9-14	1.67
16) Other Maintenance Items	$10,000- 15,000 per 2-track mile per year	0.69
D. Power		
17) Power - generated or purchased	$.30 -.33 per car mile	8.26
E. General		
18) Fringe Benefits - All employees	105.7 per cent of Item 1	15.70
19) Injuries and Damages and Claims settled	$50,000-$200,000 per line per year	0.83
20) Other General Expenses	$.30 per car mile	7.63
21) Store Expenses	1.5 per cent of items 1-20	1.46

Note: In 1973 88 per cent of costs were accounted for by items 1,3,5,7,8,9,10,13, 17,18 and 20

B. Station Operating Costs

Following wages of train operators, the greatest cost in the category Conducting Transportation is wages of station employees. These would include primarily collectors and porters (station cleaners). As of December 7, 1974 the pay for collectors was $6.4925 per hour, and for porters was $6.4850 per hour. The number of collectors needed per station on each shift varies with the number of passengers normally boarding at the station and the number of entrances open. The number of porters depends on station area and patronage.

In 1973 the average cost per station of station employees ranged from $49,500 on the Blue Line to $76,000 on the Orange Line, if stations common to two lines are counted on each line. Stations on the two Red Line branches together had average employee costs of $70,000 in 1973. This figure, with adjustments for inflation, would probably be reasonable to use as a prediction for new stations. Alternatively a minimum employee cost per station per year can be calculated assuming at least one collector is on duty 19 hours a day, every day of the year. At current wage rates this would cost $45,000 per year if shifts were arranged so as to require no overtime pay.

In addition to wages, there are expenses for utilities, cleaning materials, etc. at each station. In 1973 these costs averaged from a low of $6,300 per station on the Blue Line to a high of $15,000 per station on the Red Line.

C. Additional Transportation Expenses

The cost of Superintendence of Transportation in 1973 was approximately 20 per cent of the total wages of revenue and non-revenue train crews and station employees, with a line minimum of 19.8 per cent and maximum of 22.7 per cent. These percentages are similar to those of previous years.

Other Transportation expenses, not specified, cost the M.B.T.A. an average of $.0362 per car mile in 1973 with a range of $.0287 to $.0457 on individual lines. The cost of this item in previous years was similar.

D. Maintenance and Service of Equipment

It is probable that a portion of rapid transit car maintenance cost varies directly with car mileage, and a portion is incurred at regular time intervals, regardless of mileage. However, I have not seen any information on the relative magnitudes of these portions. Consequently I am treating car maintenance as fully determined by mileage. One problem in trying to determine maintenance cost from annual operating data is that certain major service components require overhaul or replacement at intervals-several years long, but the operating data do not reveal the appropriate mileage over which to distribute such cost. On each of the existing M.B.T.A. rapid transit lines the cars now in use were purchased in at most two orders. Failures of individual car components associated either with time or mileage are likely to occur at about the same time for cars of the same age, and this can lead to substantial distortion of maintenance cost per mile reported during a given year.

In 1973 the cost of maintaining and servicing M.B.T.A. rapid transit cars averaged $.4668 per car mile systemwide. On individual lines the averages were: Main Line $.4115, Cambridge-Dorchester $.5646, South Shore $.4330 and East Boston $.4629. Of this cost, an average of $.1360 per car mile was for routine car cleaning and servicing. The cars on the two Red Line branches might be expected to have higher maintenance costs due to their greater size and design speed. However, the greater age of the cars on the other lines offsets the advantage, if any of their smaller size. The relatively high maintenance cost for the Cambridge-Dorchester cars in 1973 was largely due to the necessity to replace faulty electrical insulation components on all older cars, and to perform this work in as short a time as possible. Prior to 1973 these cars had not had a history of unusually high maintenance cost.

Six additional cost items are associated with maintenance and servicing of rapid transit cars, but are less direct than those listed above. These are: Maintenance of Service Equipment, Shop Equipment, Shop Expenses, Maintenance of Automotive and Miscellaneous Equipment, Carhouse and Bus Garage Expenses, and Superintendence of Equipment. The cost per car mile of each of these items is very similar on all M.B.T.A. rapid transit lines, and together the six items averaged $.1365 per car mile in 1973.

E. Maintenance of Way and Structures

In 1973 the M.B.T.A. spent an average of $.8725 per car mile on maintenance of way and structures on its rapid transit lines. However, there was a wide spread in the range of costs measured on a route by route basis, largely due to the different engineering characteristics described at the beginning of this memo. The present form used for the M.B.T.A. Statement of Cost of Service breaks Maintenance of Way and Structures into 13 items for each rapid transit line. The most important of these are discussed below.

On M.B.T.A. rapid transit lines the largest single annual expense item in Maintenance of Way and Structures is usually Maintenance of Buildings, Fixtures, and Grounds. This item consists primarily of maintenance of stations, parking lots, and repair shops. The cost of maintaining stations probably increases with the number of passengers using them, but should not be directly determined by car miles. Lacking more detailed information on station maintenance cost, one can obtain an approximation of annual cost per station by dividing total cost of Maintenance of Buildings, Fixtures, and Grounds by the number of stations. For 1973 this method produces per station costs as follows: Red Line (including Quincy) $83,500; Orange Line $67,600; Blue Line $53,200. These figures would represent upper bound averages, because no maintenance cost is attributed to buildings other than stations. If car shops are weighted the same as stations, the 1973 costs per station by line are reduced to the following: Red Line (including Quincy) $79,900; Orange Line $56,300; Blue Line $49,000. The M.B.T.A. attributes costs of all maintenance between Harvard and Columbia Junction approximately equally between the Cambridge-Dorchester line and the Quincy line.

The Expenses for buildings, fixtures, and grounds for 1973 may include costs of major improvements to fire exits in all subway tunnels begun that year.

The second largest annual maintenance expense on M.B.T.A. rapid transit lines is usually track work. A portion of such expense such as the cost of regular inspections is independent of traffic volume. Track located outside of subway tunnels is exposed to the elements and will deteriorate more rapidly as a result. Although, as I have mentioned in my memo on commuter railroad costs, the variability of some track maintenance items with traffic volume is still disputed in the rail industry, volumes on all M.B.T.A. rapid transit lines are sufficiently great that it can be assumed that maintenance cost will vary directly with changes in traffic volume. Furthermore it is probably not unreasonable to approximate the marginal cost per car mile as the average cost per car mile.

In 1973 the M.B.T.A. spent an average of $.2083 per car mile for track work on its rapid transit lines. The Orange Line has always been the most expensive, and had a cost of $.3165 per car mile in 1973. The high cost of track work on this route is probably caused in large measure by the difficulty of performing track work on the elevated structure used on most of this route.

The lowest cost for track work on M.B.T.A. rapid transit lines in 1973 was on the South Shore line, with an average of $.1289 per car mile. One of the primary reasons for use of welded rail, such as is found throughout the South Shore extension, is that it is supposed to have lower maintenance cost than conventional bolted rail. The experience to date on the South Shore line supports this, but as the line has only been in operation since September 1971 there are no data on long term maintenance characteristics. The figure of $.1289 per car mile includes a share of track maintenance cost in the Cambridge-Dorchester Tunnel. If it is assumed that track work cost on this segment attributable to South Shore trains is $.1920 per car mile, the average amount charged to trains running between Harvard and Ashmont, then track work on the South Shore extension itself cost only $.0680 per car mile in 1973.

Track work on the East Boston line in 1973 cost $.1789 per car mile, slightly less than the cost on the Cambridge-Dorchester line.

The M.B.T.A. statements of cost of service distribute maintenance expenses of tunnels, subways, and elevated structures on each line over car mileage operated on the entire line. Since such structures do not extend the full length of any line, the average costs per car mile shown are not meaningful. On the basis of a knowledge of actual tunnel and elevated mileage, more useful measures can be derived, however.

It is unlikely that much new elevated structure will be included in future M.B.T.A. extensions. Short elevated sections may be used to eliminate crossings at grade with streets or railroads, but these would probably bear little structural similarity to existing elevated structure. As a point of information in 1973 the average mainteance cost of elevated structure on the Orange Line was $104,000 per mile of double track.

There is a wide range in maintenance costs per mile of subways on different M.B.T.A. lines. As yet I have not been able to fully explain this variance. For all years examined the Washington St. Tunnel on the Orange Line was most costly to maintain. In 1973 maintenance of this facility amounted to

$97,700 per mile of double track, compared with an average $29,000 per mile for all tunnels on the Red Line and $25,900 for all Green Line tunnels. The Blue Line in 1973 had a maintenance cost of $63,674 per mile of double track,but this figure appears to include some deferred maintenance or non-repetitive items. Prior to 1973 tunnel maintenance per mile on the Blue Line had cost about 30 per cent more than the same item on the Red Line. The spread in maintenance costs on the different lines may be partially a result of economies of scale in deployment of equipment and labor. The Red Line has the most subway mileage, and the Orange Line the least.

In 1973 the combined cost of maintenance and operation of signals and interlockers averaged $27,391 per mile of rapid transit track, excluding yards, on the M.B.T.A. On a line by line basis, the average costs were: Blue Line $24,108 per mile, Red Line (both branches)$27,096 per mile, and Orange Line $30,279 per mile. The Red Line cost would probably be most similar to that of new extensions. Trackside signals are used exclusively on all lines except for the South Shore Extension of the Red Line, which has cab signals throughout. The Statement of Cost of Service does not separate the cost charged to the South Shore line of signals between Harvard and Columbia Junction from the cost between Columbia Junction and Quincy Center.

The cost of maintaining power distribution systems (i.e. third rail, catenary, and supporting structures) is most appropriately expressed in dollars per car mile. In 1973 the distribution system maintenance averaged $.0150 per car mile on the Cambridge-Dorchester Line, $.0090 per car mile on the South Shore Line (including the subway portion), and $.0197 per car mile on the Orange Line. All of these lines use third-rail power throughout. On the Blue Line, which has catenary power for over 70 per cent of its length, distribution system maintenance averaged $.0768 per car mile overall. Assuming that third rail maintenance cost on the Blue Line would be close to the cost on the Cambridge-Dorchester Line, and that most trains run from Bowdoin to Wonderland, the cost per car mile of maintaining catenary and support structures would average about $.1000 per car mile.

The maintenance items discussed above amount to about 90 per cent of the total maintenance of way and structures expenses on each M.B.T.A. rapid transit line. A major portion of the remaining share is made up of superintendence costs. The Statement of Costs does not allocate superintendence costs to specific tasks, but presumably each maintenance function has some associated superintendence. In 1973 Superintenance of Way and Structures amounted to 8 to 10 per cent of the sum of all other way and structures costs on each M.B.T.A. rapid transit line.

The small remaining portion of Way and Structures Cost is composed of six items: Removal of Snow and Ice; Bridges, Culverts, and Trestles; Crossing, Fences and Signs; Communication System; Miscellaneous Way Expenses; and Miscellaneous Electric Line Expenses. The first item is difficult to predict, since it depends on the amount of snowfall each year. Most of this cost is incurred in clearing station entrances, parking lots, and platforms, as it is not necessary to plow tracks except after very severe storms. In 1973, with an unusually mild winter the M.B.T.A. spent an average of $3,950 per mile of rapid transit route for snow removal. In 1969, with an unusually severe winter, an average of $10,200 per mile was spent on snow removal. This would be equivalent to about $15,000 per mile at 1973 prices. The five other way and structures items combined cost an average of $5,700 per mile of rapid transit line in 1973.

F. Power

In 1973 the cost of power for M.B.T.A. rapid transit lines excluding distribution systems amounted to an average of $.3383 per car mile. The M.B.T.A.'s existing power stations are old and costly to operate, and will eventually be replaced. A reduction of power costs should result when the new plants are placed in operation.

Due to limited capacity of the M.B.T.A.'s own power plants, all power for the South Shore extension is purchased. Therefore the itemized power expenses for that line in the Statement of Costs are not fully comparable with those of other M.B.T.A. rapid transit routes. The total amount spent on purchased power for the South Shore line is reported in the annual budget, but the number of car miles produced with this power are not reported in any source I have seen. However, reasonable assumptions about this mileage result in a cost of $.300 to $.332 per car mile. Presumably this rate covers cost of fuel, and shares of the costs of power plant equipment, buildings, fixtures and grounds, employees and superintendence plus a margin of profit. Cars on the South Shore line operate at higher speeds than those on other M.B.T.A. routes and might therefore be expected to have higher power costs. However,the cost estimated above of purchased power used on the South Shore line is almost the same as the cost of M.B.T.A. generated power on the remainder of the Red Line. A more precise analysis of the relative costs of purchased and generated power should be conducted. The largest single cost item in for M.B.T.A. generated power is fuel. The cost of fuel for power generation increased sharply beginning in 1970, initially as the result of a requirement to change to low-sulphur fuel to reduce air pollution, and later as the result of the general fuel shortage. In 1973 the average cost of fuel for power ranged from a low of $.1687 per car mile on the Cambridge-Dorchester line to a high of $.1964 per car mile on the Orange Line.

The second largest item in power cost is Power Plant Equipment (maintenance) and the third largest is Power Plant Employees. The M.B.T.A. allocates these costs to lines in proportion to the power used, except that costs incurred at substations on individual lines are apparently assigned directly to the lines. This method is not unreasonable assuming that the cost of maintaining the plants is directly proportional to power output. Power superintendence costs are allocated on the same basis. The cost of the three above-mentioned items ranged from $.145 per car mile on the Cambridge-Dorchester Line to $.169 on the Orange Line.

In addition to the items listed above there are three items in the category of Power that make relatively small contributions to total cost. These are: Power Plant Buildings, Fixtures and Grounds; Transmission System and Miscellaneous Supplies for Power. the cost of buildings depends on the number of installations and could be affected by the general magnitude of traffic, but would not vary with small changes in service. The opening of the South Shore extension had no noticeable effect on this cost, which in 1973 amounted to $54,000 for all rapid transit lines combined. Transmission System costs would vary most with route miles. In 1973 this item cost $900 per mile on the Orange Line, $450 per mile on the Red Line, and $2,500 per mile on the Blue Line. The relative magnitudes of transmission costs on these lines have been similar in other years. The high cost on the Blue Line appears to be attributable to the catenary system. If the transmission system for the third rail portion of the Blue Line has cost characteristics similar to those of the Red Line, then the cost of maintaining the transmission system for the catenary portion alone was $3,350 per route mile. Miscellaneous supplies for power cost a total of about $11,000 in 1973, or $.0011 per car mile.

G. General Expenses

Approximately one fourth of the rapid transit operating expenses shown in the Statement of Costs are placed in the category General Expenses. Many of the items in this category are distributed to the lines by allocation formulas rather than by direct accounting. In 1972 and 1973 the breakdown for most costs distributed by allocation formulas was 33.3 per cent Main Line, 24.2 per cent Cambridge-Dorchester, 24.2 per cent South Shore, and 18.2 per cent East Boston. This breakdown is approximately that of the Category Conducting Transportation in the 1972 Statement.

1) Fringe Benefits

The item Pensions and Gratuities accounted for nearly 58 per cent of General Expenses of rapid transit in 1973. This item includes all fringe benefits, except Workmen's Compensation and Social Security Taxes, for all M.B.T.A. personnel associated with rapid transit. Fringe benefits provided by the M.B.T.A. are essentially the same for all job categories. The largest single component of fringe benefits is pension fund contributions. The present pension agreement requires the M.B.T.A. to contribute to the fund an amount equal to 11 5/8 per cent of wages earned by employees, at either straight time or overtime rates, with no maximum annual contribution per employee. In addition to pension fund contributions the M.B.T.A. pays Social Security taxes equal to 5.85 per cent of the first $13,200 of each employee's wages. The amount of Social Security payments is dependent on Federal Law and increases as Social Security benefits increase. At present it appears appropriate to treat Social Security payments as directly variable with wages. (The Statement of Cost of service places Social Security Taxes in the Category Taxes rather than in General Expenses).

Much of the remaining fringe benefit cost consists of fixed monthly payments for each employee, independent of his or her earnings. The authority currently pays $19.18 per employee per month for accident and health and life insurance policies, plus hospitalization insurance ranging from $1.94 to $7.77 per employee per month depending on the option he or she selects.

Employees losing six or more days of work due to injuries incurred on the job are paid Workmen's Compensation in the amount of $90 per week plus $6 per week for each dependent. The annual cost to the authority depends on the number and seriousness of lost time injuries. Based on recent experience an amount equal to 1.4 per cent of total wages should be allowed for workmen's compensation.

Uniforms and Work clothes are supplied by the M.B.T.A. to employees as needed. The cost of uniforms for train crews presently averages about 70 dollars per man per year.

Although fringe benefits could be estimated from a knowledge of the number of employees and their wages, many of the items in the Statement of Costs include components of both labor and materials. An alternate method of estimations is to relate fringe benefits of all workers to wages in the largest single labor category - trainmen. It is more difficult to predict the future behavior of fringe benefit costs than that of wages, because the former costs are influenced not only by inflation but by the number and nature of items included. The ratio of fringe benefits to wages is rising, but not in a regular pattern.

In 1973 the cost of total fringe benef , except Social Security taxes of all rapid transit workers equalled 105.7 per cent of wages of rapid transit trainmen on all routes. With a range from 95.0 on the Blue Line to 120.6 on the two Red Line branches combined. The South Shore line ratio would be most representative of new extensions, but due to the use of allocation formulas instead of actual expenses in the Statement of Cost it is not possible to compute a ratio for this line alone.

2) Injuries and Damages and Claims Settled

The cost of injuries and damages and claims settled is dependent on the number and severity of accidents occurring on each line. These costs appear to be assigned to the rapid transit lines according to where the accidents took place, but due to the time required for court decisions or out of court settlements, much of the amount shown in the Statement of Cost of Service for any given year would be the result of injuries and amanges suffered in previous years. None of the rapid transit lines has consistently had the highest or lowest cost for claims settled and injuries and damages awarded each year, either on an absolute basis or a per car mile basis. During the past five years the maximum amount of these two items charged to one line in a single year was $223,000, less than two per cent of the line's total cost for the year.

3) Other General Expenses

Of the nine remaining items in the category General Expenses eight are distributed between the rapid transit lines according to the allocation formula described at the beginning of this section. The items thus distributed are: Salaries and Expenses of General Offices, Salaries and Expenses of General Office Clerks, General Office Supplies and Expenses, Law Expenses, Miscellaneous General Expenses, Insurance, Stationery and Printing, and Service Garage Supplies and Expenses. In theory many general expense items should be fixed with respect to car mileage, and expansion of service would reduce the cost per mile of these items. The opening of the South Shore extension provides a potential test for this theory. However, with the data I have it is not possible to separate the effects of inflation from the effects of opening the South Shore Line, because the rate of change in General Expenses from year to year had not been following a regular pattern.

The allocation formula for the seven general expense items listed above is not based on car mileage, and the resulting cost per mile varies substantially between routes. In 1973 this cost ranged from $.2604 per car mile on the Blue Line to $.3755 per car mile on the Orange Line. The average for all lines was $.3013 per car mile.

Store Expenses, the final item in the General Expense category consists of costs involved in procurement and storage of materials used in all departments. Store expenses can be computed as a per cent of total operating costs, since the stores function is related to a large proportion of all other functions. In recent years Store Expenses have amounted to about 1.5 per cent of all operating expenses of each rapid transit line.